	L #	Hits	Type	Search Text	DBs
1	L1	91	BRS	fetac fe-ta-c fecta fe-c-ta	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB
2	L2	2078350	BRS	perpendicular vertical	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB
3	L3	119835	BRS	magnetic adj recording	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB
4	L4	50	BRS	1 and 2 and 3	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB

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Tanahashi et al. (43) Pub. Date: Apr. 25, 2002

(54) PERPENDICULAR MAGNETIC RECORDING MEDIA AND MAGNETIC STORAGE APPARATUS USING THE SAME

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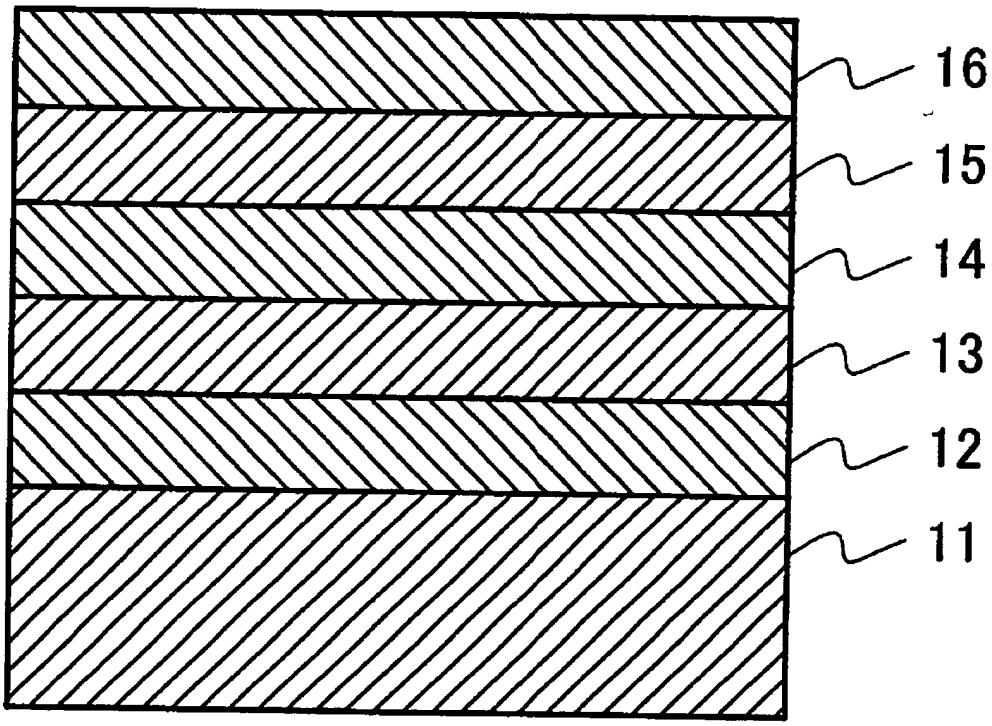
(52) U.S. Cl. ..... 428/694 TS

(57) ABSTRACT

A double layer perpendicular magnetic recording medium having a high medium S/N ratio at a recording density of 50 Gb/in^2 or higher and a magnetic storage apparatus with a lower error rate and excellent reliability are provided.

In a perpendicular magnetic recording medium in which a soft magnetic underlayer **12**, an intermediate layer **13** and a perpendicular magnetic recording layer **14** are sequentially formed on a substrate **11**, the intermediate layer **13** is made to be a non-magnetic amorphous alloy, in which Ni is a main component and Zr is contained, and the soft magnetic underlayer **12** is constituted of ferromagnetic nano-crystals precipitated by annealing.



using the non-magnetic material underlayer are disclosed in: Japanese Patent Laid-open No. Sho 58(1983)-77025 and No. Sho 58(1983)-141435 gazettes in which Ti is used as the underlayer of a Co—Cr perpendicular magnetic recording layer; Japanese Patent Laid-open No. Sho 60(1985)-214417 gazette in which Ge and Si are used as the underlayer; Japanese Patent Laid-open No. Sho 60(1985)-064413 gazette in which an oxide such as CoO and NiO is used as the underlayer; and Japanese Patent Laid-open No. 2000-30236 gazette in which MgO is used.

[0010] When the present inventors considered applying such non-magnetic underlayer materials for the intermediate layer of the double layer perpendicular magnetic recording medium, various problems have become clear. In the double layer perpendicular magnetic recording medium, since the intermediate layer is formed on the soft magnetic underlayer, a microstructure of the intermediate layer receives an influence in the case where poly-crystalline materials such as Ni—Fe and Fe—Al—Si and where amorphous materials such as Co—Nb—Zr and Co—Ta—Zr are used for the soft magnetic underlayer. As a result, the c-axis vertical orientation and the magnetic property of the perpendicular magnetic recording layer change significantly. For example, when Ti is used for the intermediate layer, although it shows a relatively good property on the amorphous soft magnetic underlayer, the c-axis vertical orientation of the perpendicular magnetic recording layer is degraded on the poly-crystalline soft magnetic underlayer, there is seen a tendency that a sufficient magnetic property cannot be obtained. In addition, in the double layer perpendicular magnetic recording medium, it is effective that a film thickness of the intermediate layer is made to be thinner in order to increase recording and reproduction efficiency. However, for example, when the amorphous material such as Ge is used for the intermediate layer, it is difficult to make the intermediate layer thin because diffusion easily occurs at the interface.

[0011] The present inventors, after considering various materials for the intermediate layer to be formed between the soft magnetic underlayer and the perpendicular magnetic recording layer, found out the following. When the non-magnetic amorphous alloy is used, in which Ni is made to be a main component and Zr is contained, the perpendicular orientation of the perpendicular magnetic recording layer becomes strong and small crystal grains are obtained (regardless of) whether the microstructure of the soft magnetic underlayer is poly-crystalline or amorphous. With a composition of the intermediate layer of an Ni—Zr series alloy, the above-described effect is obtained when the layer is non-magnetic and amorphous. By adding at least one kind of element of Nb and Ta, the non-magnetic and amorphous intermediate layer can be formed under various film forming processing conditions. When the intermediate layer of the present invention is used, a change of magnetic property owing to the film thickness of the intermediate layer is small, and deterioration of the magnetic property is not seen even in the case where the film thickness is as thin as 2 nm. In other words, an influence of the structure and magnetization of the soft magnetic underlayer to the perpendicular magnetic recording layer can be efficiently cut off. The reason is considered that the material for the intermediate layer of the present invention has a smaller interfacial diffusion and a higher covering ratio in comparison with the amorphous material such as Ge, Si and C. The film thickness of the intermediate layer is preferably 2 nm or more and 20 nm or less in order to break a magnetic coupling between the soft magnetic underlayer and the perpendicular magnetic recording layer, and to increase the recording-reproduction efficiency. Moreover, the material for the intermediate layer of the present invention can be also used for the underlayer of the single layer perpendicular magnetic recording medium.

[0012] Reduction of the medium noise originated in the soft magnetic underlayer is attained, in the perpendicular magnetic recording medium where the soft magnetic underlayer, the intermediate layer and the perpendicular magnetic recording layer are sequentially formed on the substrate, by constituting the soft magnetic underlayer with ferromagnetic nano-crystals precipitated by annealing.

[0013] Heretofore, as the material for the soft magnetic underlayer, the poly-crystalline materials such as Ni—Fe and Fe—Al—Si and the amorphous materials such as Co—Nb—Zr and Co—Ta—Zr have been proposed. The present inventors found out that the spike noise seen in the conventional soft magnetic underlayer materials can be reduced and the transition noise originated in the soft magnetic underlayer can be also reduced when a material is used for the soft magnetic underlayer, the material such is substantially amorphous and has a small saturation magnetic flux density at the time of film forming, in which ferromagnetic nano-crystals are precipitated and a high saturation magnetic flux density is obtained by annealing. As a precipitated ferromagnetic nano-crystal, any of α-Fe, fcc-Co and hcp-Co is effective, but α-Fe is the most desirable because a low coercivity and a high saturation magnetic flux density can be easily obtained. For example, when the soft magnetic underlayer is adopted where the α-Fe nano-crystals were precipitated, elements and compositions of the soft magnetic underlayer materials are not specifically limited as long as the materials precipitate the α-Fe nano-crystals. Specific examples of the materials are an Fe—Ta—C alloy, an Fe—Hf—C alloy, an Fe—Zr—C alloy, an Fe—Nb—C alloy, an Fe—Ti—C alloy and the like. When any of these materials is used and annealing suitable for each of the materials is performed, α-Fe nano-crystals can be uniformly precipitated. Moreover, the α-Fe nano-crystals can be also obtained by sputtering an Fe—Ta alloy or an Fe—Hf alloy in an Ar/N_2 mixed gas.

[0014] Generally speaking, the soft magnetic underlayer can be made to be the one that contains Fe as a first element, at least one of C and N as a second element, and at least one kind of element selected from Ta, Hf, Nb, Ti and Zr as a third element. The soft magnetic underlayer has a small spike noise even if it is directly used. However, when a pinning layer utilizing an interlayer anti-ferromagnetic coupling or a ferromagnetic coupling is provided between the soft magnetic underlayer and the substrate to control the magnetic domains, the spike noise is more effectively reduced.

[0015] As the perpendicular magnetic recording layer to be used for the perpendicular magnetic recording medium of the present invention, a Co—Cr—Pt alloy, a Co—Cr—Pt—Ta alloy, a Co—Cr—Pt—B alloy and the like can be used. As a protective layer of a perpendicular magnetic recording layer, a film having a film thickness of 3 nm or more and 10 nm or less with carbon as a main component is formed, in addition, a lubricant layer such as perfluoroalkylpolyether or the like is formed in the film thickness of 1 nm or more and

PATENT ABSTRACTS OF JAPAN

US 10/025784

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H01F 10/14
H01F 10/26

(21)Application number : 2000-401913

(22)Date of filing : 28.12.2000

(71)Applicant : HITACHI LTD

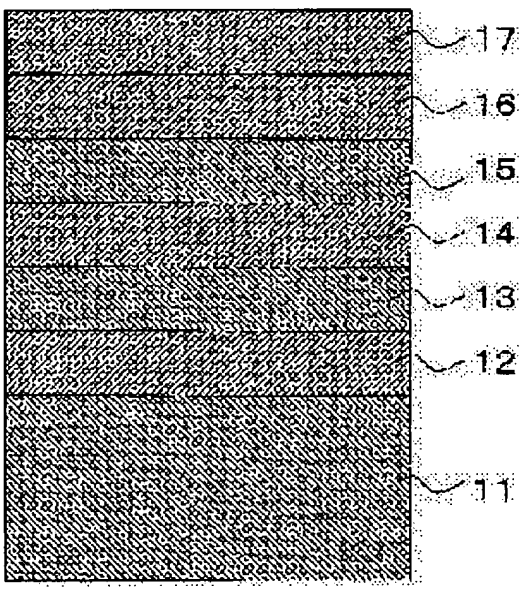
(72)Inventor : TANAHASHI KIWAMU
KIKUKAWA ATSUSHI
HONDA YUKIO

(54) VERTICAL MAGNETIC RECORDING MEDIUM AND MAGNETIC STORAGE DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a two-layered vertical magnetic recording medium having ≥50 Gbit/in2 recording density and high medium S/N and to provide a magnetic storage device having a low error rate and excellent reliability.

SOLUTION: In the vertical magnetic recording medium formed by successively laminating a pre-coated layer 12, a soft magnetic base layer 13, an intermediate layer 14 and a vertical recording layer 15 on a substrate 11, the soft magnetic base layer 13 consists essentially of Fe, Ta and C and has ≥8 at.% and ≤15 at.% Ta concentration and the ratio of C connection to the Ta concentration (C concentration/Ta concentration) of ≥0.5 and ≤0.9.



LEGAL STATUS

[Date of request for examination] 28.12.2000

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rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] It is the vertical-magnetic-recording medium which it has the soft-magnetism ground layer formed on the substrate, the nonmagnetic interlayer formed on this soft-magnetism ground layer, and the vertical recording layer formed on this interlayer, and the aforementioned soft-magnetism ground layer contains Fe, and Ta and C, and is characterized by this Ta concentration being less than [more than 8at%15at%].
[Claim 2] The vertical-magnetic-recording medium by which the ratio (Ta concentration / C concentration) of the aforementioned Ta concentration and C concentration is characterized by or more 0.5 being 0.9 or less in a vertical-magnetic-recording medium according to claim 1.
[Claim 3] The vertical-magnetic-recording medium characterized by amorphous or nonmagnetic having a microcrystal precoat layer between the aforementioned substrate and the aforementioned soft-magnetism ground layer in a vertical-magnetic-recording medium according to claim 1 or 2.
[Claim 4] The soft-magnetism ground layer formed on the substrate. The nonmagnetic interlayer formed on this soft-magnetism ground layer. The vertical recording layer formed on this interlayer. It is the vertical-magnetic-recording medium equipped with the above, and when coercive force within a field of the aforementioned soft-magnetism ground layer which impressed and measured the magnetic field in the head run direction at the temperature of 298K and 173K is set to Hc (298K) and Hc (173K), respectively, Hc (298K) is 1 or less Oe, and it is characterized by Hc (173K) being 3 or more Oes.
[Claim 5] It is the vertical-magnetic-recording medium which Hc (298K) is 1 or less Oe when coercive force within a field of the aforementioned soft-magnetism ground layer which impressed and measured the magnetic field in the head run direction at the temperature of 298K and 173K in the vertical-magnetic-recording medium of a publication in any 1 term of claims 1-3 is set to Hc (298K) and Hc (173K), respectively, and is characterized by Hc (173K) being 3 or more Oes.
[Claim 6] The mechanical component which drives a vertical-magnetic-recording medium and this vertical-magnetic-recording medium given in any 1 term of claims 1-5 in the record direction, The magnetic head equipped with the Records Department and the reproduction section, and a means to make the aforementioned magnetic head motion relatively to the aforementioned vertical-magnetic-recording medium, Magnetic storage characterized by consisting of high sensitivity elements for which it has a record regeneration means for performing output signal reproduction from the signal input of the aforementioned magnetic head, and this magnetic head, and the aforementioned magnetic-head reproduction section used the magnetoresistance effect or the magnetic tunnel effect.

[Translation done.]

1-5 = 1-6 of US appl.
6 = 7-8 of US appl.

h g cg b eb cg e e h g

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=> file reg
COST IN U.S. DOLLARS                                    SINCE FILE      TOTAL
                                                           ENTRY    SESSION
FULL ESTIMATED COST                                         0.21       0.21

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Experimental and calculated property data are now available.  See HELP
PROPERTIES for more information.  See STNote 27, Searching Properties
in the CAS Registry File, for complete details:
http://www.cas.org/ONLINE/STN/STNOTES/stnotes27.pdf

=> s fe.ta.c/rc
L1          92 FE.TA.C/RC

=> s fe.c.ta/rc
L2          13 FE.C.TA/RC

=> d l2 1-
YOU HAVE REQUESTED DATA FROM 13 ANSWERS - CONTINUE? Y/(N):y

L2   ANSWER 1 OF 13  REGISTRY  COPYRIGHT 2003 ACS
RN   488118-50-9  REGISTRY
CN   Iron alloy, base, Fe 94-100,Mn 0-1.5,Si 0-1.5,Cr 0-0.8,Mo 0-0.8,V 0-0.3,C
     0.1-0.2,Hf 0-0.2,Ni 0-0.2,Ta 0-0.2,Ti 0-0.2,Zr 0-0.2 (9CI)  (CA INDEX
     NAME)
MF   C . Cr . Fe . Hf . Mn . Mo . Ni . Si . Ta . Ti . V . Zr
CI   AYS
SR   CA
LC   STN Files:   CA, CAPLUS

Component    Component      Component
              Percent    Registry Number
=========+=============+===============
    Fe      94   - 100       7439-89-6
    Mn       0   -   1.5     7439-96-5
    Si       0   -   1.5     7440-21-3
    Cr       0   -   0.8     7440-47-3
    Mo       0   -   0.8     7439-98-7
    V        0   -   0.3     7440-62-2
    C      0.1   -   0.2     7440-44-0
    Hf       0   -   0.2     7440-58-6
    Ni       0   -   0.2     7440-02-0
    Ta       0   -   0.2     7440-25-7
    Ti       0   -   0.2     7440-32-6
    Zr       0   -   0.2     7440-67-7

             1 REFERENCES IN FILE CA (1962 TO DATE)
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1 REFERENCES IN FILE CAPLUS (1962 TO DATE)

L2 ANSWER 2 OF 13 REGISTRY COPYRIGHT 2003 ACS
RN 464216-24-8 REGISTRY
CN Iron alloy, base, Fe 1.2-99,Co 0-21,Cr 0-21,W 0-20,V 0-15,Mo 0-10,C 0.5-3.7,Mn 0-2.9,Nb 0-2,Ta 0-2,Ni 0-1,S 0-0.5 (9CI) (CA INDEX NAME)
MF C . Co . Cr . Fe . Mn . Mo . Nb . Ni . S . Ta . V . W
CI AYS
SR CA
LC STN Files: CA, CAPLUS, USPATFULL

Component	Component Percent	Component Registry Number
Fe	1.2 - 99	7439-89-6
Co	0 - 21	7440-48-4
Cr	0 - 21	7440-47-3
W	0 - 20	7440-33-7
V	0 - 15	7440-62-2
Mo	0 - 10	7439-98-7
C	0.5 - 3.7	7440-44-0
Mn	0 - 2.9	7439-96-5
Nb	0 - 2	7440-03-1
Ta	0 - 2	7440-25-7
Ni	0 - 1	7440-02-0
S	0 - 0.5	7704-34-9

1 REFERENCES IN FILE CA (1962 TO DATE)
1 REFERENCES IN FILE CAPLUS (1962 TO DATE)

L2 ANSWER 3 OF 13 REGISTRY COPYRIGHT 2003 ACS
RN 406459-96-9 REGISTRY
CN Iron alloy, base, Fe 79-99,Ni 0-5,Si 0-4,Cr 0-2,Mn 0-2,Mo 0-2,V 0-2,C 0.3-1,Cu 0-1,Ta 0.5,Ti 0-0.5,W 0-0.5,Nb 0-0.2,Al 0-0.1 (9CI) (CA INDEX NAME)
MF C . Al . Cr . Cu . Fe . Mn . Mo . Nb . Ni . Si . Ta . Ti . V . W
CI AYS
SR CA
LC STN Files: CA, CAPLUS

Component	Component Percent	Component Registry Number
Fe	79 - 99	7439-89-6
Ni	0 - 5	7440-02-0
Si	0 - 4	7440-21-3
Cr	0 - 2	7440-47-3
Mn	0 - 2	7439-96-5
Mo	0 - 2	7439-98-7
V	0 - 2	7440-62-2
C	0.3 - 1	7440-44-0
Cu	0 - 1	7440-50-8
Ta	0.5	7440-25-7
Ti	0 - 0.5	7440-32-6
W	0 - 0.5	7440-33-7
Nb	0 - 0.2	7440-03-1
Al	0 - 0.1	7429-90-5

1 REFERENCES IN FILE CA (1962 TO DATE)
1 REFERENCES IN FILE CAPLUS (1962 TO DATE)

L2 ANSWER 4 OF 13 REGISTRY COPYRIGHT 2003 ACS
RN 278614-53-2 REGISTRY
CN Steel, Fe 98-100,Mn 0-1.5,Si 0-0.4,Al 0-0.1,C 0-0.1,Nb 0-0.1,Ta 0-0.1,V

0-0.1 (9CI) (CA INDEX NAME)
MF C . Al . Fe . Mn . Nb . Si . Ta . V
CI AYS
SR CA
LC STN Files: CA, CAPLUS

Component	Component Percent	Component Registry Number
Fe	98 - 100	7439-89-6
Mn	0 - 1.5	7439-96-5
Si	0 - 0.4	7440-21-3
Al	0 - 0.1	7429-90-5
C	0 - 0.1	7440-44-0
Nb	0 - 0.1	7440-03-1
Ta	0 - 0.1	7440-25-7
V	0 - 0.1	7440-62-2

1 REFERENCES IN FILE CA (1962 TO DATE)
1 REFERENCES IN FILE CAPLUS (1962 TO DATE)

L2 ANSWER 5 OF 13 REGISTRY COPYRIGHT 2003 ACS
RN 263273-77-4 REGISTRY
CN Iron alloy, base, Fe 96-100,Mn 0-1.5,Cr 0-0.5,Cu 0-0.5,Mo 0-0.5,Ni 0-0.5,Si 0-0.4,Al 0-0.1,C 0-0.1,Nb 0-0.1,Ta 0-0.1,V 0-0.1 (9CI) (CA INDEX NAME)
MF C . Al . Cr . Cu . Fe . Mn . Mo . Nb . Ni . Si . Ta . V
CI AYS
SR CA
LC STN Files: CA, CAPLUS

Component	Component Percent	Component Registry Number
Fe	96 - 100	7439-89-6
Mn	0 - 1.5	7439-96-5
Cr	0 - 0.5	7440-47-3
Cu	0 - 0.5	7440-50-8
Mo	0 - 0.5	7439-98-7
Ni	0 - 0.5	7440-02-0
Si	0 - 0.4	7440-21-3
Al	0 - 0.1	7429-90-5
C	0 - 0.1	7440-44-0
Nb	0 - 0.1	7440-03-1
Ta	0 - 0.1	7440-25-7
V	0 - 0.1	7440-62-2

1 REFERENCES IN FILE CA (1962 TO DATE)
1 REFERENCES IN FILE CAPLUS (1962 TO DATE)

L2 ANSWER 6 OF 13 REGISTRY COPYRIGHT 2003 ACS
RN 226572-63-0 REGISTRY
CN Iron alloy, base, Fe 79-100,Cr 0-6,Ni 0-5,Si 0-2.5,Co 0-2,Mn 0-2,Cu 0-1,Mo 0-1,C 0.4-0.8,Nb 0-0.3,V 0-0.3,Ta 0-0.1,Ti 0-0.1 (9CI) (CA INDEX NAME)
MF C . Co . Cr . Cu . Fe . Mn . Mo . Nb . Ni . Si . Ta . Ti . V
CI AYS
SR CA
LC STN Files: CA, CAPLUS

Component	Component Percent	Component Registry Number
Fe	79 - 100	7439-89-6
Cr	0 - 6	7440-47-3

Ni	0	-	5	7440-02-0
Si	0	-	2.5	7440-21-3
Co	0	-	2	7440-48-4
Mn	0	-	2	7439-96-5
Cu	0	-	1	7440-50-8
Mo	0	-	1	7439-98-7
C	0.4	-	0.8	7440-44-0
Nb	0	-	0.3	7440-03-1
V	0	-	0.3	7440-62-2
Ta	0	-	0.1	7440-25-7
Ti	0	-	0.1	7440-32-6

1 REFERENCES IN FILE CA (1962 TO DATE)
1 REFERENCES IN FILE CAPLUS (1962 TO DATE)

L2 ANSWER 7 OF 13 REGISTRY COPYRIGHT 2003 ACS
RN 226572-62-9 REGISTRY
CN Iron alloy, base, Fe 81-100,Cr 0-6,Ni 0-5,Si 0-2.5,Mn 0-2,Cu 0-1,Mo 0-1,C 0.4-0.8,Nb 0-0.3,V 0-0.3,Ta 0-0.1,Ti 0-0.1 (9CI) (CA INDEX NAME)
MF C . Cr . Cu . Fe . Mn . Mo . Nb . Ni . Si . Ta . Ti . V
CI AYS
SR CA
LC STN Files: CA, CAPLUS

Component	Component Percent			Component Registry Number
Fe	81	-	100	7439-89-6
Cr	0	-	6	7440-47-3
Ni	0	-	5	7440-02-0
Si	0	-	2.5	7440-21-3
Mn	0	-	2	7439-96-5
Cu	0	-	1	7440-50-8
Mo	0	-	1	7439-98-7
C	0.4	-	0.8	7440-44-0
Nb	0	-	0.3	7440-03-1
V	0	-	0.3	7440-62-2
Ta	0	-	0.1	7440-25-7
Ti	0	-	0.1	7440-32-6

1 REFERENCES IN FILE CA (1962 TO DATE)
1 REFERENCES IN FILE CAPLUS (1962 TO DATE)

L2 ANSWER 8 OF 13 REGISTRY COPYRIGHT 2003 ACS
RN 225648-92-0 REGISTRY
CN Iron alloy, base, Fe 20-100,Al 0-32,Ni 0-30,Cr 0-10,Mo 0-2,Si 0-2,Nb 0-1,Ta 0-1,Zr 0-1,Y 0-0.5,C 0-0.3,B 0-0.1 (9CI) (CA INDEX NAME)
MF C . Al . B . Cr . Fe . Mo . Nb . Ni . Si . Ta . Y . Zr
CI AYS
SR CA
LC STN Files: CA, CAPLUS, USPATFULL

Component	Component Percent			Component Registry Number
Fe	20	-	100	7439-89-6
Al	0	-	32	7429-90-5
Ni	0	-	30	7440-02-0
Cr	0	-	10	7440-47-3
Mo	0	-	2	7439-98-7
Si	0	-	2	7440-21-3
Nb	0	-	1	7440-03-1
Ta	0	-	1	7440-25-7
Zr	0	-	1	7440-67-7

Y	0	-	0.5	7440-65-5
C	0	-	0.3	7440-44-0
B	0	-	0.1	7440-42-8

1 REFERENCES IN FILE CA (1962 TO DATE)
1 REFERENCES IN FILE CAPLUS (1962 TO DATE)

L2 ANSWER 9 OF 13 REGISTRY COPYRIGHT 2003 ACS
RN 196087-71-5 REGISTRY
CN Steel, Fe 99,C 0.4,Ta 0.4 (9CI) (CA INDEX NAME)
MF C . Fe . Ta
CI AYS
SR CA
LC STN Files: CA, CAPLUS

Component	Component Percent	Component Registry Number
Fe	99	7439-89-6
C	0.4	7440-44-0
Ta	0.4	7440-25-7

1 REFERENCES IN FILE CA (1962 TO DATE)
1 REFERENCES IN FILE CAPLUS (1962 TO DATE)

L2 ANSWER 10 OF 13 REGISTRY COPYRIGHT 2003 ACS
RN 152317-92-5 REGISTRY
CN Iron alloy, base, Fe 28-100,Ta 0-68,C 0-4.5 (9CI) (CA INDEX NAME)
OTHER NAMES:
CN Carbon 0-30, iron 40-100, tantalum 0-30 (atomic)
MF C . Fe . Ta
CI AYS
SR CA
LC STN Files: CA, CAPLUS

Component	Component Percent			Component Registry Number
Fe	28	-	100	7439-89-6
Ta	0	-	68	7440-25-7
C	0	-	4.5	7440-44-0

1 REFERENCES IN FILE CA (1962 TO DATE)
1 REFERENCES IN FILE CAPLUS (1962 TO DATE)

L2 ANSWER 11 OF 13 REGISTRY COPYRIGHT 2003 ACS
RN 82664-68-4 REGISTRY
CN Steel, (CK-Besten 60Y) (9CI) (CA INDEX NAME)
OTHER NAMES:
CN CK-BESTEN 60Y
MF C . Fe . Mn . Nb . Si . Ta . V
CI AYS
LC STN Files: CA, CAPLUS

Component	Component Percent			Component Registry Number
Fe	98	-	100	7439-89-6
Mn	0	-	1.5	7439-96-5
Si	0	-	0.6	7440-21-3
C	0	-	0.2	7440-44-0
Nb	0	-	0.1	7440-03-1
Ta	0	-	0.1	7440-25-7
V	0	-	0.1	7440-62-2

2 REFERENCES IN FILE CA (1962 TO DATE)
2 REFERENCES IN FILE CAPLUS (1962 TO DATE)

L2 ANSWER 12 OF 13 REGISTRY COPYRIGHT 2003 ACS
RN 58126-55-9 REGISTRY
CN Iron alloy, base, Fe 78-100,Be 0-5,Nb 0-5,Ta 0-5,Zr 0-5,C 0.3-1.6 (9CI) (CA INDEX NAME)
MF C . Be . Fe . Nb . Ta . Zr
CI AYS
LC STN Files: CA, CAPLUS

Component	Component Percent	Component Registry Number
Fe	78 - 100	7439-89-6
Be	0 - 5	7440-41-7
Nb	0 - 5	7440-03-1
Ta	0 - 5	7440-25-7
Zr	0 - 5	7440-67-7
C	0.3 - 1.6	7440-44-0

1 REFERENCES IN FILE CA (1962 TO DATE)
1 REFERENCES IN FILE CAPLUS (1962 TO DATE)

L2 ANSWER 13 OF 13 REGISTRY COPYRIGHT 2003 ACS
RN 56036-87-4 REGISTRY
CN Iron alloy, base, Fe 93-100,Si 0-2,Mn 0-1.5,Mo 0-0.6,Nb 0-0.6,Ta 0-0.6,Zr 0-0.6,Ti 0-0.4,V 0-0.4,C 0-0.1 (9CI) (CA INDEX NAME)
MF C . Fe . Mn . Mo . Nb . Si . Ta . Ti . V . Zr
CI AYS
LC STN Files: CA, CAPLUS

Component	Component Percent	Component Registry Number
Fe	93 - 100	7439-89-6
Si	0 - 2	7440-21-3
Mn	0 - 1.5	7439-96-5
Mo	0 - 0.6	7439-98-7
Nb	0 - 0.6	7440-03-1
Ta	0 - 0.6	7440-25-7
Zr	0 - 0.6	7440-67-7
Ti	0 - 0.4	7440-32-6
V	0 - 0.4	7440-62-2
C	0 - 0.1	7440-44-0

1 REFERENCES IN FILE CA (1962 TO DATE)
1 REFERENCES IN FILE CAPLUS (1962 TO DATE)

=> file hcaplus

COST IN U.S. DOLLARS	SINCE FILE ENTRY	TOTAL SESSION
FULL ESTIMATED COST	30.68	30.89

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FILE COVERS 1907 - 28 Mar 2003 VOL 138 ISS 14
FILE LAST UPDATED: 27 Mar 2003 (20030327/ED)

This file contains CAS Registry Numbers for easy and accurate substance identification.

=> s l1
L3 83 L1

=> s l2
L4 13 L2

=> s magnetic
L5 736902 MAGNETIC

=> s l3 and l5
L6 60 L3 AND L5

=> s l4 and l5
L7 1 L4 AND L5

=> d

L7 ANSWER 1 OF 1 HCAPLUS COPYRIGHT 2003 ACS
AN 1994:82348 HCAPLUS
DN 120:82348
TI APFIM studies of nanostructured **magnetic** materials
AU Hono, K.; Sakurai, T.
CS Inst. Mater. Res., Tohoku Univ., Sendai, 980, Japan
SO Annales de Chimie (Paris, France) (1993), 18(5-6), 311-18
CODEN: ANCPAC; ISSN: 0151-9107
DT Journal; General Review
LA English

=> d all

L7 ANSWER 1 OF 1 HCAPLUS COPYRIGHT 2003 ACS
AN 1994:82348 HCAPLUS
DN 120:82348
TI APFIM studies of nanostructured **magnetic** materials
AU Hono, K.; Sakurai, T.
CS Inst. Mater. Res., Tohoku Univ., Sendai, 980, Japan
SO Annales de Chimie (Paris, France) (1993), 18(5-6), 311-18
CODEN: ANCPAC; ISSN: 0151-9107
DT Journal; General Review
LA English
CC 55-0 (Ferrous Metals and Alloys)
Section cross-reference(s): 77
AB This paper reviews, with 22 refs., the authors' recent atom probe studies of nanostructured **magnetic** materials such as nanocryst. iron based soft **magnetic** materials (Fe-Si-B-Nb-Cu and Fe-Ta-C) for recording head applications and Co-Cr thin films for recording media applications.
ST review iron soft **magnetic** alloy; cobalt chromium film recording

review
IT Recording materials
(**magnetic**, atom probe studies of nanostructured)
IT 119635-71-1, Finemet **152317-92-5**, Carbon 0-30, iron 40-100, tantalum 0-30 (atomic) 152654-03-0, Co22Cr
RL: PROC (Process)
(nanostructure evaluation of)

=> s magnetic (2a) recording
736902 MAGNETIC
134255 RECORDING
L8 26906 MAGNETIC (2A) RECORDING

=> s l3 and l8
L9 41 L3 AND L8

=> d 1-
YOU HAVE REQUESTED DATA FROM 41 ANSWERS - CONTINUE? Y/(N):y

L9 ANSWER 1 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:886540 HCAPLUS
DN 137:379089
TI Perpendicular **magnetic recording** medium and its use in magnetic memory device
IN Sakamoto, Harumi; Matsunuma, Satoru; Yano, Akira; Takayama, Takanobu; Konuma, Takeshi; Baba, Masahiko; Takeuchi, Teruaki; Fujita, Shiochi
PA Hitachi Maxell Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 8 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI JP 2002334415	A2	20021122	JP 2001-133878	20010501
PRAI JP 2001-133878		20010501		

L9 ANSWER 2 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:792751 HCAPLUS
DN 137:303710
TI High-density **magnetic recording** media with reduced thermal fluctuation and low noise, and their memory apparatus
IN Takayama, Takanobu; Konuma, Takeshi; Yano, Akira; Wakabayashi, Koichiro; Sakamoto, Harumi; Baba, Masahiko; Fujita, Shiochi; Matsunuma, Satoru
PA Hitachi Maxell Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 8 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI JP 2002304715	A2	20021018	JP 2001-110427	20010409
PRAI JP 2001-110427		20010409		

L9 ANSWER 3 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:773759 HCAPLUS
DN 137:303694
TI Vertical **magnetic recording** media
IN Kawada, Yasuyuki
PA Fuji Electric Co., Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 11 pp.
CODEN: JKXXAF

DT Patent
LA Japanese
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI JP 2002298336	A2	20021011	JP 2001-102272	20010330
PRAI JP 2001-102272		20010330		

L9 ANSWER 4 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:716207 HCAPLUS
DN 137:251506
TI Sealing glass for magnetic heads having high reliability and performance for high-density-**recording**-enabled **magnetic recording**/reproducing devices
IN Hasegawa, Shinya; Kanai, Mikie; Kamimoto, Tetsuya; Torii, Hideo
PA Matsushita Electric Industrial Co., Ltd., Japan
SO PCT Int. Appl., 34 pp.
CODEN: PIXXD2
DT Patent
LA Japanese
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI WO 2002072493	A1	20020919	WO 2002-JP1992	20020305
W: CN, JP, KR, US				
RW: AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR				
PRAI JP 2001-64574	A	20010308		
JP 2001-330469	A	20011029		

RE.CNT 15 THERE ARE 15 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT

L9 ANSWER 5 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:696504 HCAPLUS
DN 137:225625
TI **Magnetic recording** medium, method of producing the same and **magnetic recording** and reproducing device
IN Shimizu, Kenji; Sakai, Hiroshi; Hikosaka, Takashi; Nakamura, Futoshi
PA Showa Denko K. K., Japan
SO U.S. Pat. Appl. Publ., 21 pp.
CODEN: USXXCO
DT Patent
LA English
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI US 2002127433	A1	20020912	US 2001-29204	20011228
JP 2002358618	A2	20021213	JP 2001-400592	20011228
PRAI JP 2000-402774	A	20001228		
US 2001-268968P	P	20010216		

L9 ANSWER 6 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:625897 HCAPLUS
DN 138:32134
TI Optimization of granular double-layer perpendicular media
AU Bertero, Gerardo A.; Wachenschwanz, David; Malhotra, Sudhir; Velu, Sam; Bian, Bo; Stafford, Donald; Wu, Yan; Yamashita, Tom; Wang, Shan X.
CS Komag, Inc., San Jose, CA, 95131, USA
SO IEEE Transactions on Magnetics (2002), 38(4, Pt. 1), 1627-1631
CODEN: IEMGAQ; ISSN: 0018-9464
PB Institute of Electrical and Electronics Engineers
DT Journal
LA English
RE.CNT 11 THERE ARE 11 CITED REFERENCES AVAILABLE FOR THIS RECORD

ALL CITATIONS AVAILABLE IN THE RE FORMAT

L9 ANSWER 7 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:573441 HCAPLUS
DN 137:149164
TI Perpendicular **magnetic recording** media for ultra-high-density recording and their hard disk drives
IN Tamai, Ichiro; Yamamoto, Tomoo; Hosoe, Yuzuru
PA Hitachi Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 7 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 2002216338	A2	20020802	JP 2001-13538	20010122
PRAI	JP 2001-13538		20010122		

L9 ANSWER 8 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:539348 HCAPLUS
DN 137:102833
TI Vertical **magnetic recording** media and **magnetic** memory devices
IN Tanahashi, Motomu; Kikukawa, Atsushi; Honda, Yukio
PA Hitachi Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 7 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 2002203307	A2	20020719	JP 2000-401913	20001228
	US 2002122958	A1	20020905	US 2001-25784	20011226
PRAI	JP 2000-401913	A	20001228		

L9 ANSWER 9 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:518104 HCAPLUS
DN 137:102827
TI **Magnetic recording** medium, its manufacture, and **magnetic recording**/reproducing apparatus for it
IN Shimizu, Kenji; Sakai, Hiroshi
PA Showa Denko K. K., Japan
SO Jpn. Kokai Tokkyo Koho, 14 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 2002197643	A2	20020712	JP 2000-396074	20001226
PRAI	JP 2000-396074		20001226		

L9 ANSWER 10 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:394969 HCAPLUS
DN 137:209594
TI Low-noise FeTaC underlayer for double-layered perpendicular recording media
AU Tanahashi, K.; Kikukawa, A.; Takahashi, Y.; Hosoe, Y.; Futamoto, M.
CS Central Research Laboratory, Hitachi Ltd., Kokubunji-shi, Tokyo, 185-8601, Japan
SO Journal of Magnetism and Magnetic Materials (2002), 242-245(Pt. 1), 325-327

CODEN: JMMMDC; ISSN: 0304-8853
PB Elsevier Science B.V.
DT Journal
LA English
RE.CNT 4 THERE ARE 4 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT

L9 ANSWER 11 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:368787 HCAPLUS
DN 136:378903
TI **Magnetic recording** medium and **magnetic recording** apparatus
IN Inaba, Nobuyuki; Kouda, Tetsunori; Yamanaka, Hideaki; Matsunuma, Satoshi; Fujita, Enji
PA Hitachi Maxell Ltd., Japan
SO PCT Int. Appl., 78 pp.
CODEN: PIXXD2
DT Patent
LA Japanese
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI WO 2002039433	A1	20020516	WO 2001-JP9811	20011109
W: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, AM, AZ, BY, KG, KZ, MD, RU, TJ, TM				
RW: GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW, AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR, BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG				
JP 2002208129	A2	20020726	JP 2001-301089	20010928
AU 2002012743	A5	20020521	AU 2002-12743	20011109
PRAI JP 2000-341392	A	20001109		
WO 2001-JP9811	W	20011109		

RE.CNT 7 THERE ARE 7 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT

L9 ANSWER 12 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:349306 HCAPLUS
DN 136:378883
TI Ultrahigh-density magnetic memory media possessing multilayered auxiliary magnetic layers and apparatus therewith
IN Kirino, Fumiyoshi; Fujita, Shioji; Yano, Akira; Wakabayashi, Koichiro; Matsunuma, Satoru
PA Hitachi Maxell Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 15 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI JP 2002133635	A2	20020510	JP 2000-325388	20001025
PRAI JP 2000-325388		20001025		

L9 ANSWER 13 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:272922 HCAPLUS
DN 136:303051
TI **Magnetic recording** medium and apparatus
IN Kirino, Fumiyoshi; Inaba, Nobuyuki; Takeuchi, Teruaki; Matsunuma, Satoru; Wakabayashi, Koichiro
PA Hitachi Maxell Ltd., Japan

SO Jpn. Kokai Tokkyo Koho, 12 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 2002109714	A2	20020412	JP 2000-301572	20001002
PRAI	JP 2000-301572		20001002		

L9 ANSWER 14 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:255922 HCAPLUS
DN 136:303043
TI Vertical **magnetic recording** media
IN Oikawa, Soichi; Hikosaka, Kazushi; Nakamura, Futoshi
PA Toshiba Corp., Japan
SO Jpn. Kokai Tokkyo Koho, 7 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 2002100030	A2	20020405	JP 2000-287720	20000921
	US 2002058160	A1	20020516	US 2001-808427	20010315
PRAI	JP 2000-287720	A	20000921		

L9 ANSWER 15 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:193162 HCAPLUS
DN 136:225727
TI Vertical **magnetic recording** media and **magnetic** memory devices
IN Tanahashi, Kiwamu; Kikukawa, Atsushi; Honda, Yukio; Futamoto, Masaaki; Ishikawa, Akira
PA Hitachi Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 9 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 2002074648	A2	20020315	JP 2000-266093	20000901
	US 2002048693	A1	20020425	US 2001-785416	20010220
PRAI	JP 2000-266093	A	20000901		

L9 ANSWER 16 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:193153 HCAPLUS
DN 136:256074
TI Perpendicular **magnetic recording** medium and **magnetic** memory device
IN Honda, Yukio; Tanahashi, Motomu; Kikugawa, Atsushi; Hirayama, Yoshiyuki; Futamoto, Masaaki
PA Hitachi Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 13 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 2002074639	A2	20020315	JP 2000-254168	20000824
PRAI	JP 2000-254168		20000824		

L9 ANSWER 17 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2001:903521 HCAPLUS
DN 136:30689
TI Perpendicular **magnetic recording** medium and **magnetic** memory device
IN Honda, Yukio; Hirayama, Yoshiyuki; Futamoto, Masaaki; Kikukawa, Atsushi
PA Hitachi Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 10 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI JP 2001344726	A2	20011214	JP 2000-158925	20000529
JP 3340420	B2	20021105		
PRAI JP 2000-158925		20000529		

L9 ANSWER 18 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2001:736481 HCAPLUS
DN 136:62884
TI MFM study of **magnetic** interaction between **recording** and soft **magnetic** layers
AU Honda, Y.; Tanahashi, K.; Hirayama, Y.; Kikukawa, A.; Futamoto, M.
CS Central Research Laboratory, Hitachi Ltd., Kokubunji, Tokyo, 185-8601, Japan
SO Journal of Magnetism and Magnetic Materials (2001), 235(1-3), 126-132
CODEN: JMMMDC; ISSN: 0304-8853
PB Elsevier Science B.V.
DT Journal
LA English
RE.CNT 8 THERE ARE 8 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT

L9 ANSWER 19 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2001:245304 HCAPLUS
DN 135:13302
TI Effect of soft magnetic underlayer on magnetization microstructure of perpendicular thin film media
AU Honda, Yukio; Kikukawa, Atsushi; Hirayama, Yoshiyuki; Futamoto, Masaaki
CS Central Research Laboratory, Hitachi Ltd., Kokubunji, 185-8601, Japan
SO IEEE Transactions on Magnetics (2000), 36(5, Pt. 1), 2399-2401
CODEN: IEMGAQ; ISSN: 0018-9464
PB Institute of Electrical and Electronics Engineers
DT Journal
LA English
RE.CNT 4 THERE ARE 4 CITED REFERENCES AVAILABLE FOR THIS RECORD
ALL CITATIONS AVAILABLE IN THE RE FORMAT

L9 ANSWER 20 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2001:228392 HCAPLUS
DN 134:246492
TI Information recording medium, and method and apparatus for information recording and reproduction
IN Matsumoto, Koji; Ozaki, Kazuyuki; Tagawa, Ikuya
PA Fujitsu Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 24 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI JP 2001084546	A2	20010330	JP 1999-264370	19990917

PRAI JP 1999-264370 19990917

L9 ANSWER 21 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1997:682110 HCAPLUS
DN 128:9662
TI Shielded magnetoresistance effect recording heads
IN Yamamoto, Hidefumi; Nakada, Masafumi; Hayashi, Kazuhiko; Fujikata, Junichi; Ishihara, Kunihiko
PA NEC Corp., Japan
SO Jpn. Kokai Tokkyo Koho, 6 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI JP 09270321	A2	19971014	JP 1996-76923	19960329
PRAI JP 1996-76923		19960329		

L9 ANSWER 22 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1996:446376 HCAPLUS
DN 125:103296
TI Amorphous magnetic iron alloy film and composite magnetic head
IN Obata, Akihisa; Morya, Koichi; Miura, Yoshitsugu; Miura, Takeshi
PA Hitachi Ltd, Japan
SO Jpn. Kokai Tokkyo Koho, 5 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI JP 08124744	A2	19960517	JP 1994-259993	19941025
PRAI JP 1994-259993		19941025		

L9 ANSWER 23 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1996:95393 HCAPLUS
DN 124:192188
TI MIG-type soft magnetic head
IN Miura, Takeshi; Inada, Kenkichi; Yamashita, Takeo; Kumasaka, Takayuki
PA Hitachi Ltd, Japan
SO Jpn. Kokai Tokkyo Koho, 7 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI JP 07296322	A2	19951110	JP 1994-84357	19940422
PRAI JP 1994-84357		19940422		

L9 ANSWER 24 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1995:851201 HCAPLUS
DN 123:293800
TI Metal core recession and head stain studies of MIG heads sliding against cobalt-doped gamma iron oxide and metal particle tapes
AU Tsuchiya, Toshio; Bhushan, Bharat
CS Dep. of Mechanical Engineering, The Ohio State University, Columbus, OH, 43210, USA
SO Tribology Transactions (1995), 38(4), 941-9
CODEN: TRTRE4; ISSN: 1040-2004
PB Society of Tribologists and Lubrication Engineers
DT Journal
LA English

L9 ANSWER 25 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1995:693277 HCAPLUS
DN 123:100932
TI Iron-transition metal-carbon magnetic films and their production and use
IN Nakano, Asao; Tamura, Takuo Hitachi Asahiryo; Suenaga, Kazufumi Hitachi Fujim; Ogata, Kiyoshi; Sasajima, Souzou; Kumasaka, Noriyuki
PA Hitachi, Ltd., Japan
SO Eur. Pat. Appl., 23 pp.
CODEN: EPXXDW
DT Patent
LA English
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	EP 651403	A2	19950503	EP 1994-116628	19941021
	EP 651403	A3	19950913		
	R: DE, FR, GB				
	JP 07130537	A2	19950519	JP 1993-272438	19931029
	CN 1109628	A	19951004	CN 1994-119335	19941028
	CN 1079984	B	20020227		
PRAI	JP 1993-272438	A	19931029		

L9 ANSWER 26 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1995:658216 HCAPLUS
DN 123:100945
TI Carbon-iron-tantalum alloy magnetic thin film, its manufacture, and magnetic head
IN Kirino, Fumyoshi; Ootomo, Moichi; Koiso, Yoshitsugu; Moriwaki, Hidetoshi
PA Hitachi Ltd, Japan
SO Jpn. Kokai Tokkyo Koho, 6 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 07106125	A2	19950421	JP 1993-244262	19930930
PRAI	JP 1993-244262		19930930		

L9 ANSWER 27 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1995:248940 HCAPLUS
DN 122:94959
TI Sintered sputtering targets and magnetic thin films and thin film magnetic heads manufactured from them
IN Kikuchi, Makoto; Ishigami, Takashi; Sakai, Akira; Sawa, Takao
PA Tokyo Shibaura Electric Co, Japan
SO Jpn. Kokai Tokkyo Koho, 9 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 06248445	A2	19940906	JP 1993-33321	19930223
PRAI	JP 1993-33321		19930223		

L9 ANSWER 28 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1994:567468 HCAPLUS
DN 121:167468
TI Sputtering targets for magnetic films and manufacture thereof, and iron-metal-carbon soft magnetic films and manufacture thereof, and magnetic heads and **magnetic recording** reproduction apparatus therewith

IN Kazuyasu, Mutsuo; Yasukochi, Masaya; Aoki, Shigeo
PA Hitachi Metals Ltd, Japan; Yasugi Seimitsu Kk; Hitachi Ltd
SO Jpn. Kokai Tokkyo Koho, 9 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 06010122	A2	19940118	JP 1992-119748	19920413
	JP 3076141	B2	20000814		
PRAI	JP 1991-109702	A1	19910415		

L9 ANSWER 29 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1994:547437 HCAPLUS
DN 121:147437
TI Microcrystal soft magnetic alloys, magnetic heads, and **magnetic recording** devices using thereof
IN Yasukochi, Masaya; Obata, Akihisa; Miura, Yoshitsugu
PA Hitachi Ltd, Japan
SO Jpn. Kokai Tokkyo Koho, 6 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 06025828	A2	19940201	JP 1992-180723	19920708
PRAI	JP 1992-180723		19920708		

L9 ANSWER 30 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1994:259321 HCAPLUS
DN 120:259321
TI Soft magnetic properties of carbide-dispersed nanocrystalline films with high thermal stability
AU Hasegawa, N.; Saito, M.; Kataoka, N.; Fujimori, H.
CS Niigata Div., Alps Electr. Co., Ltd., Higashi-Takami, Japan
SO Journal of Materials Engineering and Performance (1993), 2(2), 181-92
CODEN: JMEPEG; ISSN: 1059-9495
DT Journal
LA English

L9 ANSWER 31 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1994:123208 HCAPLUS
DN 120:123208
TI Iron-based ferromagnetic film
IN Katsuki, Toshiyuki
PA Matsushita Electric Industrial Co., Ltd., Japan
SO U.S., 7 pp.
CODEN: USXXAM
DT Patent
LA English
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	US 5244627	A	19930914	US 1991-805141	19911211
	JP 04214206	A2	19920805	JP 1990-401897	19901213
PRAI	JP 1990-401897		19901213		

L9 ANSWER 32 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1994:82348 HCAPLUS
DN 120:82348
TI APFIM studies of nanostructured magnetic materials
AU Hono, K.; Sakurai, T.

CS Inst. Mater. Res., Tohoku Univ., Sendai, 980, Japan
SO Annales de Chimie (Paris, France) (1993), 18(5-6), 311-18
CODEN: ANCPAC; ISSN: 0151-9107
DT Journal; General Review
LA English

L9 ANSWER 33 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1993:684865 HCAPLUS
DN 119:284865
TI Anticorrosive iron base ferromagnetic films and magnetic heads therefrom
IN Nakamura, Hitoshi; Ootomo, Moichi; Koiso, Yoshitsugu
PA Hitachi, Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 5 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 05029139	A2	19930205	JP 1991-180747	19910722
PRAI	JP 1991-180747		19910722		

L9 ANSWER 34 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1992:33077 HCAPLUS
DN 116:33077
TI Iron alloy-nitride multilayer magnetic film and magnetic head using it
IN Nakamura, Hitoshi; Kobayashi, Toshio; Nakatani, Ryoichi; Kumasaka, Takayuki
PA Hitachi, Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 5 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 03132006	A2	19910605	JP 1989-268923	19891018
PRAI	JP 1989-268923		19891018		

L9 ANSWER 35 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1992:14647 HCAPLUS
DN 116:14647
TI Iron-tantalum-carbon alloy magnetic film and magnetic head using it
IN Suwabe, Shigekazu; Nishiyama, Shunichi
PA Hitachi Metals, Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 7 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 03132004	A2	19910605	JP 1989-270916	19891018
PRAI	JP 1989-270916		19891018		

L9 ANSWER 36 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1991:693368 HCAPLUS
DN 115:293368
TI **Magnetic recording** head containing iron alloy soft magnetic film
IN Hasegawa, Naoya
PA Alps Electric Co., Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 5 pp.
CODEN: JKXXAF

DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 03131006	A2	19910604	JP 1989-269697	19891017
	JP 2635422	B2	19970730		
PRAI	JP 1989-269697		19891017		

L9 ANSWER 37 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1991:668765 HCAPLUS
DN 115:268765
TI Carbide-dispersed soft magnetic films "Nanomax" with the high Bs and thermal stability
AU Hasegawa, Naoya; Saito, Masamichi
CS Alps Electr. Co., Ltd., Niigata, Japan
SO Nippon Kinzoku Gakkai Kaiho (1991), 30(4), 313-15
CODEN: NKZKAU; ISSN: 0021-4426
DT Journal; General Review
LA Japanese

L9 ANSWER 38 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1991:646413 HCAPLUS
DN 115:246413
TI Effects of additional elements (IVa .apprx. VIa) on thermal stability of iron-carbon/nickel-iron multilayers
AU Nakamura, Hitoshi; Kobayashi, Toshio
CS Cent. Res. Lab., Hitachi Ltd., Kokubunji, 185, Japan
SO Journal of Magnetism and Magnetic Materials (1991), 97(1-3), 353-8
CODEN: JMMMDC; ISSN: 0304-8853
DT Journal
LA English

L9 ANSWER 39 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1991:155700 HCAPLUS
DN 114:155700
TI Crystallization behavior of Fe-M-C (M = titanium, zirconium, hafnium, vanadium, niobium, tantalum) films
AU Hasegawa, N.; Saito, M.; Kojima, A.; Makino, A.; Misaki, Y.; Watanabe, T.
CS Niigata Div., Alps Electr. Co., Ltd., Niigata, 946, Japan
SO Nippon Oyo Jiki Gakkaishi (1990), 14(2), 319-22
CODEN: NOJGD3; ISSN: 0285-0192
DT Journal
LA Japanese

L9 ANSWER 40 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1991:54604 HCAPLUS
DN 114:54604
TI Soft magnetic alloy layers
IN Hasegawa, Naoya
PA Alps Electric Co., Ltd., Japan
SO Ger. Offen., 11 pp.
CODEN: GWXXBX
DT Patent
LA German
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	DE 4007243	A1	19900920	DE 1990-4007243	19900307
	JP 03020444	A2	19910129	JP 1989-278220	19891025
	JP 2721562	B2	19980304		
	JP 2000150232	A2	20000530	JP 1999-361941	19891025
	JP 3236277	B2	20011210		
	US 5104464	A	19920414	US 1990-473563	19900201

	US 5176806	A	19930105	US 1990-589126	19900927
	JP 08176758	A2	19960709	JP 1995-255363	19951002
	JP 3056401	B2	20000626		
PRAI	JP 1989-55570	A	19890308		
	JP 1989-278220	A	19891025		
	US 1990-473563	A3	19900201		
	JP 1995-255363	A3	19951002		

L9 ANSWER 41 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1989:87246 HCAPLUS
DN 110:87246
TI Corrosion-resistant ferromagnetic films and magnetic heads prepared from them
IN Kobayashi, Toshio; Nakatani, Ryoichi; Otomo, Shigekazu; Kumasaka, Noriyuki
PA Hitachi, Ltd., Japan
SO Ger. Offen., 10 pp.
CODEN: GWXXBX
DT Patent
LA German
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	DE 3810244	A1	19881006	DE 1988-3810244	19880325
	DE 3810244	C2	19940210		
	JP 63236304	A2	19881003	JP 1987-68820	19870325
	JP 2555057	B2	19961120		
	CN 88101596	A	19881005	CN 1988-101596	19880325
	CN 1012234	B	19910327		
PRAI	JP 1987-68820		19870325		

=>

L4 ANSWER 10 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:394969 HCAPLUS
DN 137:209594
TI Low-noise FeTaC underlayer for double-layered perpendicular recording media
AU Tanahashi, K.; Kikukawa, A.; Takahashi, Y.; Hosoe, Y.; Futamoto, M.
CS Central Research Laboratory, Hitachi Ltd., Kokubunji-shi, Tokyo, 185-8601, Japan
SO Journal of Magnetism and Magnetic Materials (2002), 242-245(Pt. 1), 325-327
CODEN: JMMMDC; ISSN: 0304-8853
PB Elsevier Science B.V.
DT Journal
LA English
CC 77-1 (Magnetic Phenomena)
Section cross-reference(s): 56
AB We have investigated the effect of the alloy compn. of FeTaC soft-magnetic underlayers on the noise properties of double-layered perpendicular recording media. Media noise is found to be strongly dependent on the FeTaC alloy compn. Low-noise properties are obsd. when the Ta and C contents are 8-10 and 10-16 at%, resp. Low-noise FeTaC underlayers are composed of small (.apprx..apprxeq.0 nm) .alpha.-Fe grains with a 3D-random orientation.
ST iron tantalum carbon underlayer double layered perpendicular recording medium
IT Coercive force (magnetic)
Magnetization
Microstructure
(low-noise FeTaC underlayer for double-layered NiTaZr/CoCrPt perpendicular recording media characterized via)
IT **Magnetic recording** materials
(perpendicular; low-noise FeTaC underlayer for double-layered NiTaZr/CoCrPt perpendicular recording media)
IT 91033-96-4 **151582-68-2**, Carbon 12, iron 80, tantalum 8 (atomic)
160536-74-3, Carbon 8, iron 84, tantalum 8 (atomic)
180028-42-6, Carbon 12, iron 78, tantalum 10 (atomic)
195534-26-0, Carbon 16, iron 76, tantalum 8 (atomic) 289659-95-6
376348-83-3, Carbon 12, iron 82, tantalum 6 (atomic)
RL: PEP (Physical, engineering or chemical process); PRP (Properties); PYP (Physical process); TEM (Technical or engineered material use); PROC (Process); USES (Uses)
(low-noise FeTaC underlayer for double-layered NiTaZr/CoCrPt perpendicular recording media)
RE.CNT 4 THERE ARE 4 CITED REFERENCES AVAILABLE FOR THIS RECORD
RE
(1) Hasegawa, N; Mater Trans JIM 1992, V33, P632 HCAPLUS
(2) Honda, Y; IEEE Trans Magn 2000, V36, P2399 HCAPLUS
(3) Kikukawa, A; IEEE Trans Magn 2000, V36, P2402 HCAPLUS
(4) Takano, H; Presented at INTERMAG 2000 (AD06)

L4 ANSWER 14 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:255922 HCAPLUS
DN 136:303043
TI Vertical **magnetic recording** media
IN Oikawa, Soichi; Hikosaka, Kazushi; Nakamura, Futoshi
PA Toshiba Corp., Japan
SO Jpn. Kokai Tokkyo Koho, 7 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
IC ICM G11B005-738
ICS G11B005-64; G11B005-667; G11B005-673
CC 77-8 (Magnetic Phenomena)

FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 2002100030	A2	20020405	JP 2000-287720	20000921
	US 2002058160	A1	20020516	US 2001-808427	20010315
PRAI	JP 2000-287720	A	20000921		

AB The title recording media comprise: nonmagnetic substrates; 1st foundation layers from Fe or Fe alloys contg. .gtoreq.1 of Ta, C, Zr, N and Co; Ru-based 2nd foundation layers; and Co-contg. magnetic layers. The magnetic layers have improved vertical orientation, and the recording media have high coercive force and high playing output.

ST vertical **magnetic recording** media foundation layer; iron alloy foundation layer recording media

IT **Magnetic recording** materials
(vertical **magnetic recording** media contg. double foundation layers)

IT Crystal orientation
Magnetic films
(vertical **magnetic recording** media contg. double foundation layers and highly-vertically-oriented magnetic layers)

IT 189817-15-0, Chromium cobalt platinum oxide
RL: DEV (Device component use); USES (Uses)
(vertical **magnetic recording** media contg. double foundation layers and highly-vertically-oriented magnetic layers from)

IT 7439-89-6, Iron, uses 7440-18-8, Ruthenium, uses 7440-47-3, Chromium, uses 7440-48-4, Cobalt, uses 12655-66-2 37327-47-2 87644-53-9 **165253-39-4** 406909-46-4
RL: DEV (Device component use); USES (Uses)
(vertical **magnetic recording** media contg. double foundation layers contg.)

L4 ANSWER 15 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2002:193162 HCAPLUS
DN 136:225727
TI Vertical **magnetic recording** media and **magnetic** memory devices
IN Tanahashi, Kiwamu; Kikukawa, Atsushi; Honda, Yukio; Futamoto, Masaaki; Ishikawa, Akira
PA Hitachi Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 9 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
IC ICM G11B005-738
ICS G11B005-667
CC 77-8 (Magnetic Phenomena)

FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 2002074648	A2	20020315	JP 2000-266093	20000901
	US 2002048693	A1	20020425	US 2001-785416	20010220
PRAI	JP 2000-266093	A	20000901		

AB The **magnetic recording** media contain nonmagnetic intermediate layers from amorphous Ni-base Zr alloys between soft magnetic foundation layers and vertical recording layers. The recording media have recording d. of .gtoreq.50 G-bits/in.2. Magnetic memory devices using the recording media have low error rate.

ST vertical **magnetic recording** media memory device; amorphous intermediate layer **magnetic recording** media

IT Magnetic films
(soft; soft magnetic foundation layers in vertical **magnetic recording** media and **magnetic** memory devices)

IT Magnetic memory devices
Magnetic recording materials

(vertical **magnetic recording** media and **magnetic** memory devices)

IT 347406-27-3
RL: DEV (Device component use); USES (Uses)
(nonmagnetic intermediate layers in vertical **magnetic recording** media and **magnetic** memory devices)

IT 166966-19-4 166966-20-7 197656-89-6
RL: DEV (Device component use); USES (Uses)
(recording layers in vertical **magnetic recording** media and **magnetic** memory devices)

IT **151582-68-2** 402468-05-7 402468-06-8 402468-07-9
402468-08-0
RL: DEV (Device component use); USES (Uses)
(soft magnetic foundation layers in vertical **magnetic recording** media and **magnetic** memory devices)

L4 ANSWER 19 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2001:245304 HCAPLUS
DN 135:13302
TI Effect of soft magnetic underlayer on magnetization microstructure of perpendicular thin film media
AU Honda, Yukio; Kikukawa, Atsushi; Hirayama, Yoshiyuki; Futamoto, Masaaki
CS Central Research Laboratory, Hitachi Ltd., Kokubunji, 185-8601, Japan
SO IEEE Transactions on Magnetics (2000), 36(5, Pt. 1), 2399-2401
CODEN: IEMGAQ; ISSN: 0018-9464
PB Institute of Electrical and Electronics Engineers
DT Journal
LA English
CC 77-1 (Magnetic Phenomena)
AB Anal. magnetic force microscopy was applied to investigate the relationship between the soft magnetic underlayer and the microscopic magnetization structures of double layered perpendicular media. The magnetization structures of the CoCrPtTa perpendicular media with Co-Nb-Zr, Co-Ta-Zr, Fe-Ta-C, and Fe-Al-Si soft magnetic underlayers are compared. The medium with Co-Ta-Zr underlayer shows low medium noise and high resoln. characteristics at high recording densities. The magnetization irregularities of perpendicular media are strongly affected by the soft magnetic underlayer material.
ST cobalt chromium tantalum platinum **magnetic recording** medium soft underlayer; magnetization microstructure **magnetic recording** medium soft underlayer

IT Noise
(magnetic; soft magnetic underlayer effect on magnetization microstructure of Co-Cr-Ta-Pt perpendicular thin film media)

IT **Magnetic recording** materials
Magnetization
(soft **magnetic** underlayer effect on magnetization microstructure of Co-Cr-Ta-Pt perpendicular thin film media)

IT 341034-99-9
RL: PEP (Physical, engineering or chemical process); PRP (Properties); TEM (Technical or engineered material use); PROC (Process); USES (Uses)
(soft magnetic underlayer effect on magnetization microstructure of Co-Cr-Ta-Pt perpendicular thin film media)

IT **151582-68-2** 341035-00-5 341035-01-6 341035-02-7
RL: PEP (Physical, engineering or chemical process); PRP (Properties); TEM (Technical or engineered material use); PROC (Process); USES (Uses)
(soft underlayer; soft magnetic underlayer effect on magnetization microstructure of Co-Cr-Ta-Pt perpendicular thin film media)

RE.CNT 4 THERE ARE 4 CITED REFERENCES AVAILABLE FOR THIS RECORD
RE
(1) Ando, T; J Magn Soc Jpn 1994, V18(Suppl S1), P87
(2) Honda, N; J Magn Soc Jpn 1997, V121(Suppl S2), P505
(3) Honda, Y; IEEE Trans Magn 1999, V35, P2682 HCAPLUS
(4) Kikukawa, A; Proc Intermag 2000 Conf 2000, VDP-08

L4 ANSWER 29 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1994:547437 HCAPLUS
DN 121:147437
TI Microcrystal soft magnetic alloys, magnetic heads, and **magnetic recording** devices using thereof
IN Yasukochi, Masaya; Obata, Akihisa; Miura, Yoshitsugu
PA Hitachi Ltd, Japan
SO Jpn. Kokai Tokkyo Koho, 6 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
IC ICM C23C014-06
ICS G11B005-127; G11B005-23; G11B005-31; H01F010-16
CC 77-8 (Magnetic Phenomena)
Section cross-reference(s): 56, 57
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI JP 06025828	A2	19940201	JP 1992-180723	19920708
PRAI JP 1992-180723		19920708		

AB The Microcrystal soft magnetic alloy contg. Fe or Co and Group IV or V carbide or nitride has a desired peak intensity ratio in a x-ray diffraction {(carbide or nitride peak intensity)/(Fe or Co peak intensity)} ratio controlled by power input d. in its sintering. The peak ratio-controlled nitride or carbide at a desired level works as a components to suppress growth of Fe or Co grains without damaging its soft magnetic coercive characteristics.
ST microcrystal soft magnetic alloy nitride carbide; x ray diffraction peak intensity ratio; iron cobalt grain growth suppression magnetic; coercive force microcrystal soft magnetic alloy
IT Coercive force, magnetic
(of microcrystal soft magnetic alloy, iron/cobalt and carbide/nitride x-ray diffraction peak ratio in relation to)
IT Magnets
(soft, microcrystal, alloy, coercive force in, iron/cobalt and carbide/nitride x-ray diffraction peak ratio in relation to)
IT **Recording** apparatus
(**magnetic** heads, microcrystal soft magnet)
IT Diffractometry
(x-ray, peak intensity of, ratio for iron/cobalt and carbide/nitride in, magnetic coercive force in relation to)
IT **157393-00-5**
RL: USES (Uses)
(microcrystal soft magnet, coercive force in, iron/cobalt and carbide/nitride x-ray diffraction peak ratio in relation to)

L4 ANSWER 20 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 2001:228392 HCAPLUS
DN 134:246492
TI Information recording medium, and method and apparatus for information recording and reproduction
IN Matsumoto, Koji; Ozaki, Kazuyuki; Tagawa, Ikuya
PA Fujitsu Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 24 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
IC ICM G11B005-66
ICS G11B005-64; G11B005-02
CC 77-8 (Magnetic Phenomena)
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE

PI JP 2001084546 A2 20010330 JP 1999-264370 19990917
PRAI JP 1999-264370 19990917
AB An information recording medium comprises a substrate having first and second magnetic layers (remanent magnetization >50 emu/cc) of amorphous rare earth transition metal alloy thin films having a magnetic anisotropy and Hc2>Hc1 and/or Tc2>Tc1, where Hc2 and Hc1 are coercivities of the second and first layers and Tc2 and Tc1 are Curie temps. of the second and first layers. The interface domain walls between the first and second layers are not formed when a magnetic field is not applied, and the reprodn. of information is carried out by detecting the magnetic flux of the first and second layers.
ST rare earth alloy **magnetic recording** app
IT Magnetic anisotropy
Magnetic films
Magnetic memory devices
Remanence
(rare earth alloy information recording medium, and method and app. for information recording and reprodn.)
IT Rare earth alloys
RL: DEV (Device component use); PRP (Properties); USES (Uses)
(rare earth alloy information recording medium, and method and app. for information recording and reprodn.)
IT 149663-57-0, Cobalt 11, iron 68, terbium 21 (atomic) **165253-39-4**, Carbon 10, iron 80, tantalum 10 (atomic) 166890-04-6, Cobalt 11, iron 70, terbium 19 (atomic) 330582-50-8, Cobalt 5, iron 80, terbium 15 (atomic) 330582-51-9, Cobalt 18, iron 60, terbium 22 (atomic) 330582-52-0, Cobalt 2, iron 81, silicon 0.04, terbium 17 (atomic) 330582-53-1, Cobalt 5, iron 77, terbium 18 (atomic) 330582-54-2, Cobalt 11, gadolinium 14, iron 75 (atomic) 330582-55-3, Cobalt 9, iron 75, terbium 16 (atomic) 330582-56-4, Chromium 0.02, cobalt 3, iron 80, terbium 17 (atomic) 330582-57-5, Cobalt 21, iron 60, terbium 19 (atomic) 330582-58-6, Cobalt 20, dysprosium 19, iron 61 (atomic) 330582-59-7, Cobalt 19, dysprosium 21, iron 60 (atomic)
RL: DEV (Device component use); USES (Uses)
(rare earth alloy information recording medium, and method and app. for information recording and reprodn.)

L4 ANSWER 27 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1995:248940 HCAPLUS
DN 122:94959
TI Sintered sputtering targets and magnetic thin films and thin film magnetic heads manufactured from them
IN Kikuchi, Makoto; Ishigami, Takashi; Sakai, Akira; Sawa, Takao
PA Tokyo Shibaura Electric Co, Japan
SO Jpn. Kokai Tokkyo Koho, 9 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
IC ICM C23C014-34
ICS G11B005-31; H01F010-12; H01F010-18; H01F041-18
CC 77-8 (Magnetic Phenomena)
Section cross-reference(s): 55, 76
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 06248445	A2	19940906	JP 1993-33321	19930223

PRAI JP 1993-33321 19930223
AB The targets contain the 1st metal elements contg. Fe, Co, and/or Ni, the 2nd metal elements contg. Ta, Ti, V, Mo, W, Nb, Hf, Zr, and/or rare earth element, and nonmetal elements contg. B, Si, C, N, P, and/or O and have compds. with the nonmetal elements. The thin films contain the 1st element-based fine grains and compds. with the 2nd elements and the nonmetal elements and are manufd. by sputtering the targets. The heads contain the thin films as magnetic thin films.

ST sputtering target sintered magnetic head; iron rare earth sputtering target

IT **Recording** materials
(**magnetic**, Fe-based sintered sputtering targets for magnetic thin films and magnetic heads)

IT Sputtering
(targets, Fe-based sintered sputtering targets for magnetic thin films and magnetic heads)

IT 134137-72-7P 139379-60-5P 160536-68-5P 160536-69-6P 160536-70-9P
160536-71-0P 160536-72-1P 160536-73-2P **160536-74-3P**
160536-75-4P 160536-76-5P 160536-77-6P 160536-78-7P 160536-79-8P
160536-80-1P 160536-81-2P 160536-82-3P 160536-83-4P 160536-84-5P
160536-85-6P 160536-86-7P 160536-87-8P 160536-88-9P 160536-89-0P
160536-90-3P 160536-91-4P 160536-92-5P 160536-93-6P 160536-94-7P
160536-95-8P 160536-96-9P 160536-97-0P 160536-98-1P 160536-99-2P
160537-00-8P 160537-01-9P 160537-02-0P 160537-03-1P 160537-04-2P
160537-05-3P 160537-06-4P 160537-07-5P 160537-08-6P 160537-09-7P
RL: DEV (Device component use); IMF (Industrial manufacture); PRP (Properties); PREP (Preparation); USES (Uses)
(Fe-based sintered sputtering targets for magnetic thin films and magnetic heads)

L4 ANSWER 40 OF 41 HCAPLUS COPYRIGHT 2003 ACS
AN 1991:54604 HCAPLUS
DN 114:54604
TI Soft magnetic alloy layers
IN Hasegawa, Naoya
PA Alps Electric Co., Ltd., Japan
SO Ger. Offen., 11 pp.
CODEN: GWXXBX
DT Patent
LA German
IC ICM H01F010-14
ICS C10L011-04; G11B005-706
CC 77-8 (Magnetic Phenomena)
Section cross-reference(s): 55
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	DE 4007243	A1	19900920	DE 1990-4007243	19900307
	JP 03020444	A2	19910129	JP 1989-278220	19891025
	JP 2721562	B2	19980304		
	JP 2000150232	A2	20000530	JP 1999-361941	19891025
	JP 3236277	B2	20011210		
	US 5104464	A	19920414	US 1990-473563	19900201
	US 5176806	A	19930105	US 1990-589126	19900927
	JP 08176758	A2	19960709	JP 1995-255363	19951002
	JP 3056401	B2	20000626		
PRAI	JP 1989-55570	A	19890308		
	JP 1989-278220	A	19891025		
	US 1990-473563	A3	19900201		
	JP 1995-255363	A3	19951002		

AB The title layers, useful in **magnetic recording** heads, have the compn. FexMzCw, where M = Ti, Zr, Hf, Nb, Ta, Mo, and/or W; 50 .ltoreq. x .ltoreq. 96; 2 .ltoreq. z .ltoreq. 30; 0.5 .ltoreq. w .ltoreq. 25; and x + z + w = 100, and comprises cryst. particles having av. size .ltoreq.0.08 .mu.m and an M carbide phase. The layers are prepd. by sputtering a composite target on which a transition metal pellet is placed and heat treatment at .gtoreq.400.degree. for 20 min.

ST soft magnetic alloy layer; iron carbon transition metal magnetic alloy; **recording** head soft **magnetic** alloy layer

IT Sputtering
(deposition by, of soft magnetic iron alloy layers)

IT **Recording** apparatus

(**magnetic** heads, iron alloy layers for)
IT Magnetic substances
(soft, iron alloy, layers, prepd. by sputter deposition)
IT 131460-37-2 131460-38-3 **131460-39-4** 131460-40-7
RL: PRP (Properties)
(soft magnetic layers from, for recording heads, prepd. by sputter deposition)

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=> s 151582-68-2
L1            1 151582-68-2
                (151582-68-2/RN)

=> d all

L1   ANSWER 1 OF 1  REGISTRY  COPYRIGHT 2003 ACS
RN   151582-68-2  REGISTRY
CN   Iron alloy, base, Fe 74,Ta 24,C 2.4 (9CI)  (CA INDEX NAME)
OTHER NAMES:
CN   Carbon 12, iron 80, tantalum 8 (atomic)
MF   C . Fe . Ta
CI   AYS
SR   CA
LC   STN Files:   CA, CAPLUS, USPATFULL

Component   Component      Component
             Percent    Registry Number
=========+=============+===============
    Fe         74            7439-89-6
    Ta         24            7440-25-7
    C           2.4          7440-44-0

              10 REFERENCES IN FILE CA (1962 TO DATE)
              10 REFERENCES IN FILE CAPLUS (1962 TO DATE)

REFERENCE  1

AN   137:209594  CA
TI   Low-noise FeTaC underlayer for double-layered perpendicular recording
     media
AU   Tanahashi, K.; Kikukawa, A.; Takahashi, Y.; Hosoe, Y.; Futamoto, M.
CS   Central Research Laboratory, Hitachi Ltd., Kokubunji-shi, Tokyo, 185-8601,
     Japan
SO   Journal of Magnetism and Magnetic Materials (2002), 242-245(Pt. 1),
     325-327
     CODEN: JMMMDC; ISSN: 0304-8853
PB   Elsevier Science B.V.
DT   Journal
LA   English
CC   77-1 (Magnetic Phenomena)
     Section cross-reference(s): 56
AB   We have investigated the effect of the alloy compn. of FeTaC soft-magnetic
     underlayers on the noise properties of double-layered perpendicular
     recording media.  Media noise is found to be strongly dependent on the
     FeTaC alloy compn.  Low-noise properties are obsd. when the Ta and C
     contents are 8-10 and 10-16 at%, resp.  Low-noise FeTaC underlayers are
     composed of small (.apprx..apprxeq.0 nm) .alpha.-Fe grains with a
     3D-random orientation.
ST   iron tantalum carbon underlayer double layered perpendicular recording
     medium
IT   Coercive force (magnetic)
     Magnetization
     Microstructure
        (low-noise FeTaC underlayer for double-layered NiTaZr/CoCrPt
        perpendicular recording media characterized via)
IT   Magnetic recording materials
        (perpendicular; low-noise FeTaC underlayer for double-layered
        NiTaZr/CoCrPt perpendicular recording media)
IT   91033-96-4   151582-68-2, Carbon 12, iron 80, tantalum 8 (atomic)
     160536-74-3, Carbon 8, iron 84, tantalum 8 (atomic)   180028-42-6, Carbon
     12, iron 78, tantalum 10 (atomic)   195534-26-0, Carbon 16, iron 76,
     tantalum 8 (atomic)   289659-95-6   376348-83-3, Carbon 12, iron 82,
```

tantalum 6 (atomic)
RL: PEP (Physical, engineering or chemical process); PRP (Properties); PYP (Physical process); TEM (Technical or engineered material use); PROC (Process); USES (Uses)
(low-noise FeTaC underlayer for double-layered NiTaZr/CoCrPt perpendicular recording media)

RE.CNT 4 THERE ARE 4 CITED REFERENCES AVAILABLE FOR THIS RECORD
(1) Hasegawa, N; Mater Trans JIM 1992, V33, P632 CAPLUS
(2) Honda, Y; IEEE Trans Magn 2000, V36, P2399 CAPLUS
(3) Kikukawa, A; IEEE Trans Magn 2000, V36, P2402 CAPLUS
(4) Takano, H; Presented at INTERMAG 2000 (AD06)

REFERENCE 2

AN 137:149164 CA
TI Perpendicular magnetic recording media for ultra-high-density recording and their hard disk drives
IN Tamai, Ichiro; Yamamoto, Tomoo; Hosoe, Yuzuru
PA Hitachi Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 7 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
IC ICM G11B005-738
ICS G11B005-65; H01F010-16; H01F010-30
CC 77-8 (Magnetic Phenomena)
FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI JP 2002216338	A2	20020802	JP 2001-13538	20010122
PRAI JP 2001-13538	20010122			

AB The magnetic recording medium, esp. magnetic disks, for .gtoreq.50 Gbit/1 in.2 has a 1st layer of face-centered lattice structure, a 2nd layer of hexagonal closest packing structure based on Co and Cr as the main component and contg. Ta, V, W, Nb, and/or Mo, and a perpendicular recording layer stacked in this order. Preferably, the 1st layer is based on Cu as the main component and contain Cr, Ta, Mo, Nb, V, W, and/or B. The 1st layer may be disposed on an amorphous layer. The media has low noise and suppressed influence of thermal fluctuation while having high cohesive force.

ST perpendicular magnetic recording medium cobalt alloy; face centered lattice cobalt alloy magnetic medium; hexagonal closest packing cobalt alloy magnetic medium; amorphous underlayer perpendicular magnetic recording medium; hard disk drive perpendicular magnetic medium

IT Magnetic disks
Magnetic memory devices
Magnetic recording materials
(perpendicular magnetic recording media for ultra-high-d. recording and their hard disk drives)

IT 7440-50-8, Copper, uses
RL: TEM (Technical or engineered material use); USES (Uses)
(1st intermediate layer, face-centered lattice structure; perpendicular magnetic recording media for ultra-high-d. recording and their hard disk drives)

IT 96439-26-8, Chromium 30, cobalt bal., tungsten 4 (atomic) 421550-43-8, Chromium 30, cobalt bal., molybdenum 4 (atomic)
RL: TEM (Technical or engineered material use); USES (Uses)
(2nd intermediate layer, hexagonal closest packing structure; perpendicular magnetic recording media for ultra-high-d. recording and their hard disk drives)

IT 308356-83-4, Boron 4, chromium 21, cobalt bal., platinum 14 (atomic) 379270-47-0, Chromium 18, cobalt bal., platinum 14, tantalum 3 (atomic)
RL: TEM (Technical or engineered material use); USES (Uses)
(recording layer; perpendicular magnetic recording media for

ultra-high-d. recording and their hard disk drives)
IT 151582-68-2, Carbon 12, iron bal., tantalum 8 (atomic) 341035-01-6, Cobalt bal., tantalum 10, zirconium 2 (atomic)
RL: TEM (Technical or engineered material use); USES (Uses)
(soft magnetic layer; perpendicular magnetic recording media for ultra-high-d. recording and their hard disk drives)
IT 444724-67-8, Chromium 30, cobalt bal., zirconium 8 (atomic)
RL: TEM (Technical or engineered material use); USES (Uses)
(underlayer; perpendicular magnetic recording media for ultra-high-d. recording and their hard disk drives)

REFERENCE 3

AN 137:102833 CA
TI Vertical magnetic recording media and magnetic memory devices
IN Tanahashi, Motomu; Kikukawa, Atsushi; Honda, Yukio
PA Hitachi Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 7 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
IC ICM G11B005-667
ICS G11B005-738; H01F010-14; H01F010-26
CC 77-8 (Magnetic Phenomena)
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 2002203307	A2	20020719	JP 2000-401913	20001228
	US 2002122958	A1	20020905	US 2001-25784	20011226

PRAI JP 2000-401913 20001228
AB The title recording media contain soft magnetic base layers contg. Fe, Ta (8-15 at.%) and C, and formed on substrates, nonmagnetic intermediate layers on the base layers, and vertical recording layers on the intermediate layers. The recording media have recording d. of .gtoreq.50 Gb/in2 and high S/N ratio. Magnetic memory devices incorporating the magnetic recording media are described.
ST vertical magnetic recording media memory device
IT Magnetic memory devices
Magnetic recording materials
(vertical magnetic recording media and magnetic memory devices)
IT 347406-27-3, Nickel 52.5, tantalum 37.5, zirconium 10 (atomic)
RL: DEV (Device component use); USES (Uses)
(precoat layers; vertical magnetic recording media and magnetic memory devices)
IT 166966-20-7, Chromium 22, cobalt 64, platinum 14 (atomic)
RL: DEV (Device component use); USES (Uses)
(recording layers; vertical magnetic recording media and magnetic memory devices)
IT 151582-68-2, Carbon 12, iron 80, tantalum 8 (atomic) 180028-42-6, Carbon 12, iron 78, tantalum 10 (atomic) 195534-26-0, Carbon 16, iron 76, tantalum 8 (atomic) 442525-65-7, Carbon 16, iron 74, tantalum 10 (atomic) 442525-66-8, Carbon 16, iron 72, tantalum 12 (atomic)
RL: DEV (Device component use); USES (Uses)
(soft magnetic layers; vertical magnetic recording media and magnetic memory devices)

REFERENCE 4

AN 136:256074 CA
TI Perpendicular magnetic recording medium and magnetic memory device
IN Honda, Yukio; Tanahashi, Motomu; Kikugawa, Atsushi; Hirayama, Yoshiyuki; Futamoto, Masaaki
PA Hitachi Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 13 pp.

CODEN: JKXXAF
DT Patent
LA Japanese
IC ICM G11B005-667
ICS G11B005-738; H01F010-14; H01F010-16; H01F010-26; H01F041-18
CC 77-8 (Magnetic Phenomena)
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 2002074639	A2	20020315	JP 2000-254168	20000824
PRAI	JP 2000-254168		20000824		

AB The magnetic recording medium has perpendicular magnitrization films through lining magnetic layers on .gtoreq.1 side of a support and the lining layer involves a film contg. soft magnetic particles with av. particle size, defined by the author's method, 1-10 nm. The soft magnetic particles may be noncolumnar polycryst. fine particles. The medium show low noise and stable magnetization. The magnetic memory device involves the above recording medium and heads for recording and reproducing of signals.
ST perpendicular magnetic recording medium; magnetic memory device recording medium; lining layer soft magnetic particle
IT Magnetic memory devices
Magnetic recording materials
(perpendicular magnetic recording medium having soft magnetic lining layer for magnetic memory device)
IT Magnetic materials
(soft; perpendicular magnetic recording medium having soft magnetic lining layer for magnetic memory device)
IT 166966-19-4, Chromium 22, cobalt 66, platinum 12 (atomic)
RL: TEM (Technical or engineered material use); USES (Uses)
(perpendicular magnetic recording medium having soft magnetic lining layer for magnetic memory device)
IT 403857-95-4
RL: TEM (Technical or engineered material use); USES (Uses)
(soft magnetic particle; in perpendicular magnetic recording medium having soft magnetic lining layer for magnetic memory device)
IT 151582-68-2, Carbon 12, iron 80, tantalum 8 (atomic) 403857-97-6
RL: TEM (Technical or engineered material use); USES (Uses)
(soft magnetic; perpendicular magnetic recording medium having soft magnetic lining layer for magnetic memory device)

REFERENCE 5

AN 136:225727 CA
TI Vertical magnetic recording media and magnetic memory devices
IN Tanahashi, Kiwamu; Kikukawa, Atsushi; Honda, Yukio; Futamoto, Masaaki; Ishikawa, Akira
PA Hitachi Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 9 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
IC ICM G11B005-738
ICS G11B005-667
CC 77-8 (Magnetic Phenomena)
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 2002074648	A2	20020315	JP 2000-266093	20000901
	US 2002048693	A1	20020425	US 2001-785416	20010220
PRAI	JP 2000-266093		20000901		

AB The magnetic recording media contain nonmagnetic intermediate layers from amorphous Ni-base Zr alloys between soft magnetic foundation layers and vertical recording layers. The recording media have recording d. of

.gtoreq.50 G-bits/in.2. Magnetic memory devices using the recording media have low error rate.

ST vertical magnetic recording media memory device; amorphous intermediate layer magnetic recording media

IT Magnetic films
(soft; soft magnetic foundation layers in vertical magnetic recording media and magnetic memory devices)

IT Magnetic memory devices
Magnetic recording materials
(vertical magnetic recording media and magnetic memory devices)

IT 347406-27-3
RL: DEV (Device component use); USES (Uses)
(nonmagnetic intermediate layers in vertical magnetic recording media and magnetic memory devices)

IT 166966-19-4 166966-20-7 197656-89-6
RL: DEV (Device component use); USES (Uses)
(recording layers in vertical magnetic recording media and magnetic memory devices)

IT 151582-68-2 402468-05-7 402468-06-8 402468-07-9 402468-08-0
RL: DEV (Device component use); USES (Uses)
(soft magnetic foundation layers in vertical magnetic recording media and magnetic memory devices)

REFERENCE 6

AN 136:62884 CA

TI MFM study of magnetic interaction between recording and soft magnetic layers

AU Honda, Y.; Tanahashi, K.; Hirayama, Y.; Kikukawa, A.; Futamoto, M.

CS Central Research Laboratory, Hitachi Ltd., Kokubunji, Tokyo, 185-8601, Japan

SO Journal of Magnetism and Magnetic Materials (2001), 235(1-3), 126-132
CODEN: JMMMDC; ISSN: 0304-8853

PB Elsevier Science B.V.

DT Journal

LA English

CC 77-8 (Magnetic Phenomena)
Section cross-reference(s): 56

AB Magnetic force microscopy was used to study the magnetic interaction between the recording and the soft magnetic layers in double-layer perpendicular media by observing the magnetization structure from the soft magnetic layer side. There was a strong magnetic interaction between the recording and the soft magnetic layers. Introducing a thin nonmagnetic intermediate layer between the two layers greatly reduced the magnetic interaction and drastically reduced the medium noise.

ST magnetization recording magnetic layer interaction; chromium cobalt platinum recording noise

IT Magnetic films
Magnetic multilayers
Magnetic recording materials
Magnetization
Noise
(MFM study of magnetic interaction between recording and soft magnetic layers)

IT 12782-62-6, Chromium 10, titanium 90 (atomic) 151582-68-2, Carbon 12, iron 80, tantalum 8 (atomic) 166966-19-4, Chromium 22, cobalt 66, platinum 12 (atomic) 377777-57-6, Cobalt 92, tantalum 3, zirconium 5 (atomic)
RL: PEP (Physical, engineering or chemical process); PRP (Properties); PYP (Physical process); TEM (Technical or engineered material use); PROC (Process); USES (Uses)
(MFM study of magnetic interaction between recording and soft magnetic layers)

RE.CNT 8 THERE ARE 8 CITED REFERENCES AVAILABLE FOR THIS RECORD

(1) Hirayama, Y; IEEE Trans Magn 1997, V33, P996 CAPLUS
(2) Hirayama, Y; Technical Report of the Institute of Electronics, Information and Communication Engineers 2000, V27(MR2000-33)
(3) Honda, Y; Digest of the 2000 IEEE International Magnetic Conference 2000, DP-07
(4) Honda, Y; IEEE Trans Magn 1997, V33, P3076 CAPLUS
(5) Iwasaki, S; IEEE Trans Magn 1980, V16, P71
(6) Kikukawa, A; Digest of the 2000 IEEE International Magnetic Conference 2000, DP-08
(7) Lien, L; IEEE Trans Magn 1994, V30, P3951
(8) Tanahashi, K; Abstract of the Fifth Perpendicular Magnetic Recording Conference 2000 2000, 23pA-12

REFERENCE 7

AN 136:30689 CA
TI Perpendicular magnetic recording medium and magnetic memory device
IN Honda, Yukio; Hirayama, Yoshiyuki; Futamoto, Masaaki; Kikukawa, Atsushi
PA Hitachi Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 10 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
IC ICM G11B005-667
ICS G11B005-738; H01F010-00; H01F010-14; H01F010-16; H01F041-18
CC 77-8 (Magnetic Phenomena)
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 2001344726	A2	20011214	JP 2000-158925	20000529
	JP 3340420	B2	20021105		
PRAI	JP 2000-158925		20000529		

AB In a perpendicular magnetic recording medium having a perpendicular magnetization film formed on a substrate via a lining magnetic layer, the magnetic layer comprises a hard magnetic film having a perpendicular easy-magnetization axis on the substrate and a soft magnetic film on the hard magnetic film. The medium has superior noise and magnetization properties. Specifically, the hard magnetic film may comprise a Co alloy contg. Cr, Pt, Ta, Hf, or Sm, and the soft magnetic film may comprise a Co-Nb-Zr amorphous alloy, Co-W-Zr amorphous alloy, Co-Ta-Zr amorphous alloy, Co-Ni-Zr amorphous alloy, Fe-Al-Si-M alloy (M=Cr, Ti), Fe-Ta-C-M alloy (M=Al, Cr), Fe-Hf-C-M alloy (M=Al, Cr), Fe-Ta-N-M alloy (M=Al, Cr), or Ni-Fe-M alloy (M=NB, Mo). A magnetic memory device comprising the above medium is also described.
ST perpendicular magnetic recording medium magnetic multilayer
IT Magnetic memory devices
Magnetic memory devices
Magnetic multilayers
(lining magnetic films in perpendicular magnetic recording medium and magnetic memory device)
IT 151582-68-2, Carbon 12, iron 80, tantalum 8 (atomic) 379270-47-0, Chromium 18, cobalt 65, platinum 14, tantalum 3 (atomic) 379270-48-1, Cobalt 85, tantalum 10, zirconium 5 (atomic) 379270-49-2, Cobalt 87, tantalum 4, zirconium 9 (atomic)
RL: DEV (Device component use); USES (Uses)
(lining magnetic films in perpendicular magnetic recording medium and magnetic memory device)

REFERENCE 8

AN 136:14523 CA
TI Noise characteristics of double-layered perpendicular media using Fe-Ta-C underlayer
AU Kikukawa, Atsushi; Tanahashi, Kiwamu; Honda, Yukio; Hirayama, Yoshiyuki;

Futamoto, Masaaki
CS Central Research Laboratory, Hitachi Ltd., Tokyo, Japan
SO IEEE Transactions on Magnetics (2001), 37(4, Pt. 1), 1602-1604
CODEN: IEMGAQ; ISSN: 0018-9464
PB Institute of Electrical and Electronics Engineers
DT Journal
LA English
CC 77-8 (Magnetic Phenomena)
AB The noise characteristics of double-layered perpendicular media having an Fe-Ta-C soft-magnetic underlayer were studied. Changes in soft magnetic properties and a consequent increase in media noise occurs when C or Ta are reduced from the std. compn. Two-dimensional spike distributions were obsd. in a medium using the std. Fe-Ta-C compn., possibly caused by temp. inhomogeneity during the annealing process. Also the noise contribution of the spikes was minimal for disks using an Fe-Ta-C SMU.
ST iron tantalum carbide soft underlayer magnetic tape noise characteristics
IT Annealing
Coercive force (magnetic)
Magnetic multilayers
Magnetic tapes
Magnetism
Noise
Remanence
X-ray diffraction
(noise characteristics of double-layered perpendicular media using Fe-Ta-C underlayer)
IT Magnetic materials
(soft; noise characteristics of double-layered perpendicular media using Fe-Ta-C underlayer)
IT 93844-66-7
RL: DEV (Device component use); PRP (Properties); TEM (Technical or engineered material use); USES (Uses)
(substrate; noise characteristics of double-layered perpendicular media using Fe-Ta-C underlayer)
IT 151582-68-2 160536-74-3 376348-83-3
RL: DEV (Device component use); PRP (Properties); TEM (Technical or engineered material use); USES (Uses)
(underlayer; noise characteristics of double-layered perpendicular media using Fe-Ta-C underlayer)
RE.CNT 5 THERE ARE 5 CITED REFERENCES AVAILABLE FOR THIS RECORD
(1) Darragh, N; IEEE Tran Magn 1993, V29, P3742
(2) Hasegawa, N; J Magn Soc Jpn, in Japanese 1990, V14, P313 CAPLUS
(3) Kikukawa, A; Distributions and characteristics of spike noise 2000
(4) Kikukawa, A; Noise characteristics of double-layered perpendicular media using novel soft magnetic underlayer materials, presented at the Digest Intermag 2000 2000
(5) Uesaka, Y; J Appl Phys 1985, V57, P3925

REFERENCE 9

AN 135:13302 CA
TI Effect of soft magnetic underlayer on magnetization microstructure of perpendicular thin film media
AU Honda, Yukio; Kikukawa, Atsushi; Hirayama, Yoshiyuki; Futamoto, Masaaki
CS Central Research Laboratory, Hitachi Ltd., Kokubunji, 185-8601, Japan
SO IEEE Transactions on Magnetics (2000), 36(5, Pt. 1), 2399-2401
CODEN: IEMGAQ; ISSN: 0018-9464
PB Institute of Electrical and Electronics Engineers
DT Journal
LA English
CC 77-1 (Magnetic Phenomena)
AB Anal. magnetic force microscopy was applied to investigate the relationship between the soft magnetic underlayer and the microscopic magnetization structures of double layered perpendicular media. The

magnetization structures of the CoCrPtTa perpendicular media with Co-Nb-Zr, Co-Ta-Zr, Fe-Ta-C, and Fe-Al-Si soft magnetic underlayers are compared. The medium with Co-Ta-Zr underlayer shows low medium noise and high resoln. characteristics at high recording densities. The magnetization irregularities of perpendicular media are strongly affected by the soft magnetic underlayer material.

ST cobalt chromium tantalum platinum magnetic recording medium soft underlayer; magnetization microstructure magnetic recording medium soft underlayer

IT Noise
(magnetic; soft magnetic underlayer effect on magnetization microstructure of Co-Cr-Ta-Pt perpendicular thin film media)

IT Magnetic recording materials
Magnetization
(soft magnetic underlayer effect on magnetization microstructure of Co-Cr-Ta-Pt perpendicular thin film media)

IT 341034-99-9
RL: PEP (Physical, engineering or chemical process); PRP (Properties); TEM (Technical or engineered material use); PROC (Process); USES (Uses)
(soft magnetic underlayer effect on magnetization microstructure of Co-Cr-Ta-Pt perpendicular thin film media)

IT 151582-68-2 341035-00-5 341035-01-6 341035-02-7
RL: PEP (Physical, engineering or chemical process); PRP (Properties); TEM (Technical or engineered material use); PROC (Process); USES (Uses)
(soft underlayer; soft magnetic underlayer effect on magnetization microstructure of Co-Cr-Ta-Pt perpendicular thin film media)

RE.CNT 4 THERE ARE 4 CITED REFERENCES AVAILABLE FOR THIS RECORD

(1) Ando, T; J Magn Soc Jpn 1994, V18(Suppl S1), P87
(2) Honda, N; J Magn Soc Jpn 1997, V121(Suppl S2), P505
(3) Honda, Y; IEEE Trans Magn 1999, V35, P2682 CAPLUS
(4) Kikukawa, A; Proc Intermag 2000 Conf 2000, VDP-08

REFERENCE 10

AN 119:284865 CA

TI Anticorrosive iron base ferromagnetic films and magnetic heads therefrom

IN Nakamura, Hitoshi; Ootomo, Moichi; Koiso, Yoshitsugu
PA Hitachi, Ltd., Japan

SO Jpn. Kokai Tokkyo Koho, 5 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
IC ICM H01F010-14
ICS C22C038-00; G11B005-31
CC 77-8 (Magnetic Phenomena)
Section cross-reference(s): 55

FAN.CNT 1

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI JP 05029139	A2	19930205	JP 1991-180747	19910722
PRAI JP 1991-180747		19910722		

AB The film contains Hf, Zr, Nb, Ta, Mo, and/or W, and fine crystals of oxide(s), and carbide(s), nitride(s), or boride(s) thereof, and Cr, Ru, Rh, and Cu in coexistence.

ST iron base alloy film magnetic head

IT Magnetic substances
(ferro-, iron base alloy, anticorrosive)

IT Recording apparatus
(magnetic heads, anticorrosive iron base alloy films)

IT 151582-68-2 151582-69-3 151582-70-6 151582-71-7 151582-72-8 151582-73-9 151582-74-0 151582-75-1 151582-76-2 151582-77-3 151582-78-4
RL: USES (Uses)
(anticorrosive ferromagnetic films from)

tic recording medium 30 to perform the function of a double layered **perpendicular** film, and the magnetic recording medium 30 is expected to produce excellent recording/reading characteristics because of the interact between the head and the soft magnetic layer.

[0069] The magnetic characteristics of the resultant magnetic recording medium were measured by a vibrating sample type magnetometer (VSM), with the results as shown in Table 1. The mark "Hc.perp." in Table 1 represents a coercive force in the case where a magnetic field is applied in a direction **perpendicular** to the film surface. Also, the mark "Hc//" in Table 1 represents a coercive force in the case where a magnetic field is applied to in a areal direction of the film surface. Further, the **perpendicular** squareness ratio represents a ratio of the residual magnetization to the saturated magnetization in the case of applying a magnetic field in a **perpendicular** direction.

[0070] A magnetic recording medium was prepared as in Example 1, except that a **FeTaC** layer having a thickness of about 100 nm was formed in place of the Fe layer. The **FeTaC** layer was formed by sputtering a **FeTaC** target containing 10 atomic % of Ta, 10 atomic % of C and the balance of Fe under an argon atmosphere. The magnetic properties of the magnetic recording medium thus obtained were measured as in Example 1, with the results as shown in Table 1.

[0087] A **perpendicular** orientation is improved with increase in the ratio Hc.perp./Hc// shown in Table 1, and an read output is increased in the case where the **perpendicular** squareness ratio shown in Table 1 is as close to 1 as possible so as to provide an excellent **perpendicular magnetic recording** medium.

iary
magnetic pole 14 is sufficiently larger than that of the main magnetic pole 13,
the magnetic flux density from the auxiliary magnetic pole 14 is sufficiently
small that the magnetization of the **perpendicular** magnetic layer 4 is not
affected by this magnetic flux from the auxiliary pole 14.

[0050] As the material with a structure having no magnetic domain walls,
FeAlSi, FeTaN, **FeTaC,** FeC, FeAlSi alloys, FeTaN alloys, **FeTaC** alloys, or
materials wherein these alloys are the main components, can be mentioned. For
example, it is possible to use a material in which Co, Ni, Ru, Si, N, O, B, C,
or Hf is added to one of the above alloys in an amount of 10 at. % or less
(preferably 7 at. % or less, more preferably 5 at. % or less).

[0051] As the material constituting the soft magnetic layer 21B, it is
possible to use Fe alloys comprising 60 atomic % or more of Fe. More
specifically, although there are no specific limitations, the following can be
mentioned: FeCo type alloys (FeCo and FeCoV, and the

US 20020127433A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2002/0127433 A1

Shimizu et al. (43) Pub. Date: Sep. 12, 2002

(54) MAGNETIC RECORDING MEDIUM, METHOD OF PRODUCING THE SAME AND MAGNETIC RECORDING AND REPRODUCING DEVICE

(75) Inventors: Kenji Shimizu, Ichihara-shi (JP); Hiroshi Sakai, Ichihara-shi (JP); Takashi Hikosaka, Tokyo (JP); Futoshi Nakamura, Ichikawa-shi (JP)

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Washington, DC 20037-3213 (US)

(73) Assignee: SHOWA DENKO K.K.

(21) Appl. No.: 10/029,204

(22) Filed: Dec. 28, 2001

Related U.S. Application Data

(60) Provisional application No. 60/268,968, filed on Feb. 16, 2001.

(30) Foreign Application Priority Data

Dec. 28, 2000 (JP) P2000-402774

Publication Classification

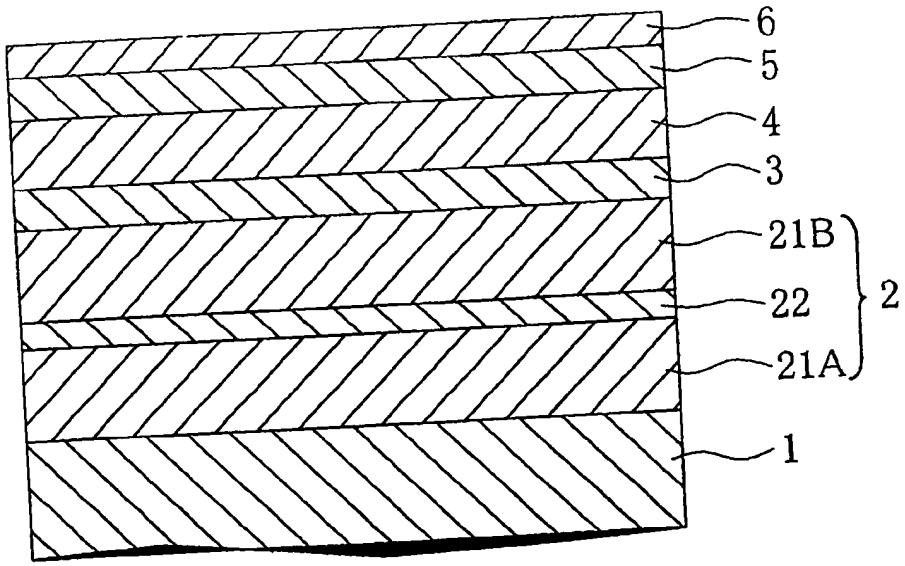
(51) Int. Cl.[7] G11B 5/667

(52) U.S. Cl. ..... 428/694 TM

(57) ABSTRACT

The present invention aims to provide a magnetic recording medium, a method for producing the same, and a magnetic recording and reproducing device which can prevent spike noise and improve the error rate.

The present invention provides a magnetic recording medium, a method for producing the same, and a magnetic recording and reproducing device comprising at least one nonmagnetic substrate, a soft magnetic underlayer 2, an orientation control layer to control the orientation of the layer formed directly above the same, and a perpendicular magnetic layer having an axis of easy magnetization which is oriented mainly perpendicularly to the nonmagnetic substrate, and the soft magnetic underlayer 2 is formed with a multilayer structure having soft magnetic layers 21A and 21B, and one or more separation layers 22 interposed between the soft magnetic layers, and at least one of the soft magnetic layers 21A and 21B comprises a material with a structure having no magnetic domain walls.



DERWENT-ACC-NO: 2002-021727

DERWENT-WEEK: 200203

TITLE: Magnetic recording medium has film thickness of intermediate layer which is set up more than film thickness of vertical magnetization layer

PATENT-ASSIGNEE: FUJITSU LTD[FUIT]

PRIORITY-DATA: 2000JP-0095898 (March 30, 2000)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
JP 2001283419 A	October 12, 2001	N/A	010	G11B 005/667

APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
JP2001283419A	N/A	2000JP-0095898	March 30, 2000

INT-CL (IPC): G11B005/667

ABSTRACTED-PUB-NO: JP2001283419A

BASIC-ABSTRACT:

NOVELTY - An intermediate layer (13) and a vertical magnetization layer (14) are laminated sequentially on a soft-magnetism foundation layer (12). The film thickness of the intermediate layer is set up more than the film thickness of the vertical magnetization layer.

DETAILED DESCRIPTION - An INDEPENDENT CLAIM is also included for a magnetic

storage.

USE - For high density recording.

ADVANTAGE - Reduces medium noise originating in soft-magnetism foundation layer without reducing record sensitivity.

DESCRIPTION OF DRAWING(S) - The figure shows the sectional view of the magnetic recording medium. (Drawing includes non-English language text)

Soft-magnetism foundation layer 12

Intermediate layer 13

Vertical magnetization layer 14

CHOSEN-DRAWING: Dwg.2/15

DERWENT-CLASS: T03

EPI-CODES: T03-A01F;

sublayer directly on the underlayer, the sublayer being a material selected from the group consisting of Ti and an alloy consisting of Ti and Cr, wherein the Ti is present in the TiCr alloy in an amount greater than or equal to 90 atomic percent and less than 100 atomic percent; and a Co alloy magnetic layer having **perpendicular** magnetic anisotropy directly on the sublayer.

5. The disk according to claim 1 further comprising a magnetically permeable flux return layer selected from the group consisting of NiFe, FeAlSi, FeTaN, FeN, CoFeB, CoTaZr, **FeTaC** and CoZrNb, the magnetically permeable flux return layer being located between the substrate and the underlayer.

6. A **perpendicular magnetic recording** disk comprising: a substrate; an underlayer on the substrate, the underlayer consisting of the binary alloy NiAl wherein Al is present in the compositional range of 4

ction is scarcely recognized among the magnetic particles. It
was impossible to identify the Curie temperature because of the change in the
film structure. However, the Curie temperature was estimated at about
300.degree. C. by extrapolation from the change with temperature up to
200.degree. C.

[0295] A magnetic recording medium according to the sixth embodiment of the
present invention, which was schematically constructed as shown in FIG. 9, was
prepared. Specifically, on a glass substrate having a diameter of 2.5 inches,
a soft magnetic underlayer made of **FeTaC** and having a thickness of 50 nm, a Ti
shielding layer having a thickness of 5 nm, a Pt underlayer having a thickness
of 10 nm, a stacked functional layer having a thickness of 18.8 nm, a stacked
recording layer having a thickness of 15 nm and a protective layer made of
carbon and having a thickness of 3 nm were successively formed by sputtering in
the order mentioned, followed by coating with a lubricant so as to prepare the
magnetic recording medium.

[0297] The stacked recording layer was prepared by repeatedly depositing
seven times a unit of [Co 0.3 nm/Pd 1.8 nm]. The fine structure of the
recording layer was examined with TEM. It has been found that the Co magnetic
crystal grains having a diameter of about 7 nm were separated from each other
by the amorphous nonmagnetic material that was assumed to be CoO. Concerning
the magnetic characteristics of the recordi

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(54) MAGNETIC RECORDING MEDIUM AND MAGNETIC RECORDING APPARATUS

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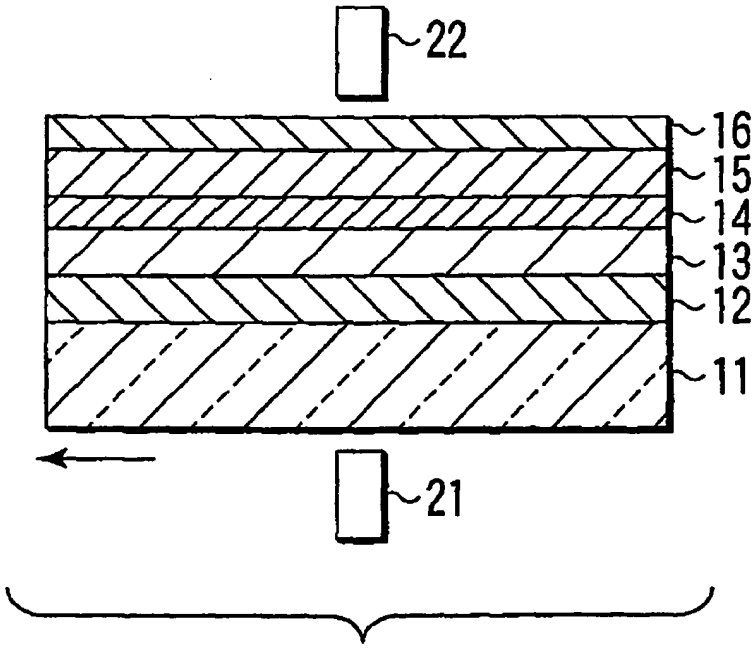
(57) ABSTRACT

A magnetic recording medium has a substrate, a base layer formed on the substrate and including a magnetic material, a switching layer formed on the base layer and including a nonmagnetic material, and a recording layer formed on the switching layer and having a structure comprising magnetic particles and a nonmagnetic wall buried between the magnetic particles. The medium meets the condition of TcB>Tsw, where TcB is a Curie temperature of the base layer, and Tsw is a temperature at which the recording layer and the base layer begin to exert exchange coupling interaction.



is shown in FIG. 2. Both the second undercoat film and the non-magnetic intermediate film 5 may be omitted. The second **perpendicular** magnetic film 6 are formed directly on the first **perpendicular** magnetic film 3. Accordingly, the first undercoat film 2 is provided in the above-described magnetic recording medium, but the film 2 may be omitted in the present invention. The magnetic recording medium not comprising the first undercoat film 2 is shown in FIG. 3.

[0079] The material of the soft magnetic layer comprises material containing Co or Fe (e.g., alloys of CoZrNb, CoTaNb, permalloy, sendust **FeTaC**).

[0083] A glass substrate 1 (diameter: 95 mm, thickness: 0.8 mm) was set in the chamber of a DC magnetron sputtering apparatus (model 3010: product of ANELVA Corporation). Subsequently, the chamber was evacuated to 2.times.10.sup.-7 Pa. Thereafter, on the substrate 1, a first undercoat film 2 comprising SiN, a first **perpendicular** magnetic film 3 comprising TbFeCo, a second undercoat film 4 comprising Ru, a non-magnetic intermediate film 5 comprising Co-35at %Cr-5at %Pt (Co35Cr5

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(54) MAGNETIC RECORDING MEDIUM

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Publication Classification

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(52) U.S. Cl. ..... 428/694 TM

(57) ABSTRACT

The present invention provides a magnetic recording medium exhibiting excellent noise characteristics and thermal stability. On a substrate, a first undercoat film, a first perpendicular magnetic film, a second undercoat film, a non-magnetic intermediate film, a second perpendicular magnetic film, and a protective film are successively formed, and the magnetic anisotropy energy of the first perpendicular magnetic film is higher than that of the second perpendicular magnetic film.

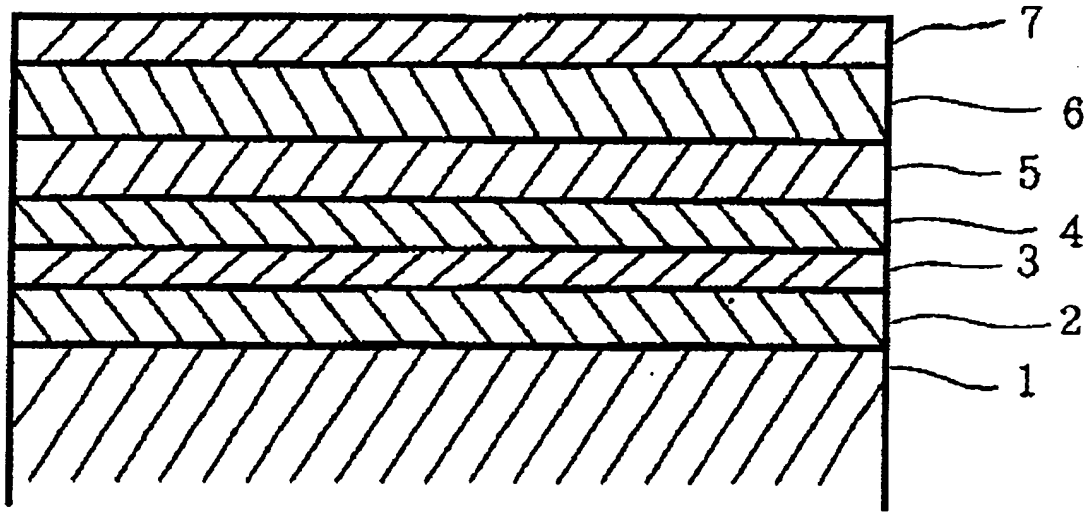


Fig. 1

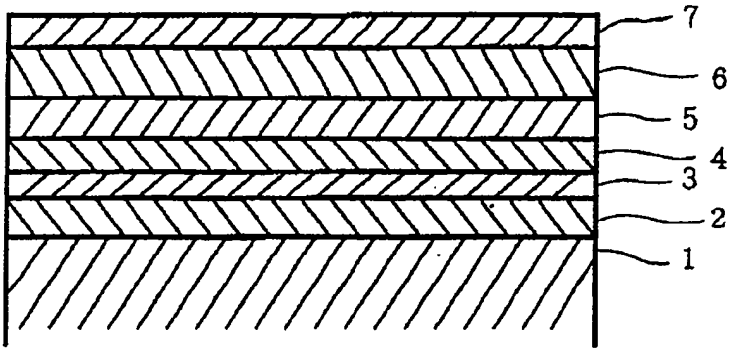


Fig. 2

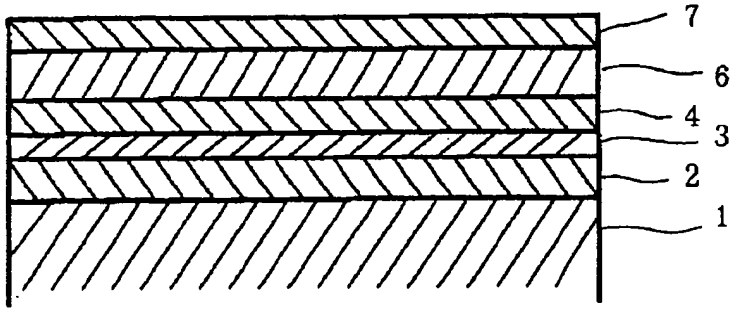
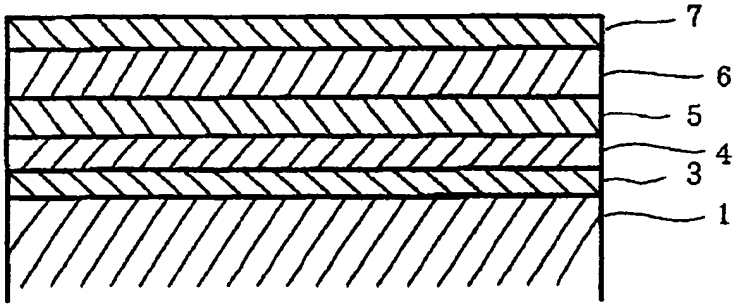


Fig. 3



MAGNETIC RECORDING MEDIUM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is an application filed under 35 U.S.C. §111(a) claiming benefit pursuant to 35 U.S.C. §119(e)(1) of the filing date of Provisional Application 60/192,546 filed Mar. 28,2000 pursuant to 35 U.S.C. §111(b).

FIELD OF THE INVENTION

[0002] The present invention relates to a magnetic recording medium which is employed in a magnetic disk apparatus and the like.

BACKGROUND OF THE INVENTION

[0003] A widely employed magnetic recording medium is of an in-plane recording type in which most of the easy-magnetization axes in the magnetic film are oriented horizontally with respect to the substrate. However, in such an in-plane magnetic recording medium, per-bit volume becomes exceedingly small and read-write characteristics may deteriorate when recording density is increased.

[0004] In contrast, in a perpendicular magnetic recording medium, in which most of the easy-magnetization axes in the magnetic film are oriented vertically with respect to the substrate, recording density can be increased without deterioration of read-write characteristics. Therefore, a perpendicular magnetic recording medium has recently become of interest, and magnetic recording medium structures suitable for perpendicular magnetic recording have been proposed.

[0005] For example, Japanese Patent Application Laid-Open (Kokai) Nos. 58-77025 and 58-141435 disclose that Ti is employed as a material for producing an undercoat layer of a perpendicular magnetic film comprising a Co alloy material. In addition, Japanese Patent Application Laid-Open (Kokai) No. 8-180360 discloses that an alloy of Co and Ru is employed as a material for producing the undercoat layer.

[0006] In recent years, there has been demand for magnetic recording media of higher recording density, and in accordance with this trend, improvement of noise characteristics has been required. However, conventional magnetic recording media are not necessarily satisfactory in terms of noise characteristics, and thus there has been demand for a magnetic recording medium that exhibits excellent noise characteristics.

[0007] Meanwhile, in a conventional magnetic recording medium, particularly when recording density is increased, a thermal fluctuation phenomenon may arise. The term "thermal fluctuation phenomenon" refers to a phenomenon in which recording bits become unstable and recorded data are lost thermally. When such a phenomenon occurs, read-write output of recorded data may lessen with passage of time in a magnetic recording apparatus.

[0008] In view of the foregoing, an object of the present invention is to provide a magnetic recording medium which exhibits excellent noise characteristics and rarely causes a thermal fluctuation phenomenon.

SUMMARY OF THE INVENTION

[0009] The present invention provides a magnetic recording medium comprising a substrate, a first perpendicular magnetic film, and a second perpendicular magnetic film in order, wherein the magnetic anisotropy energy of the first perpendicular magnetic film is higher than that of the second perpendicular magnetic film.

[0010] Preferably, the first perpendicular magnetic film has a magnetic anisotropy energy of 5×10^6.erg/cc or more.

[0011] Preferably, the ratio of residual magnetization to saturation magnetization in the first perpendicular magnetic film is 0.9 or more.

[0012] The first perpendicular magnetic film may be a multi-layer film in which layers of Co material, and Pt or Pd material are repeatedly stacked; an amorphous film containing a rare earth element; or an ordered alloy, e.g., $L1_0$-structured FePt, CoPt, $(Fe_{(1-n)}Co_n)_{50}$ Pt_{50} (n: 0-0.99).

[0013] Preferably, the first perpendicular magnetic film has a thickness of 1-175 Å, more preferably 1-100 Å.

[0014] Preferably, the second perpendicular magnetic film comprises any alloy of CoCrPt, CoCrTa, and CoCrPtX (X: one or more species selected from among Ta, Zr, Cu, Re, Nb, Si, Ge, and B).

[0015] In the magnetic recording medium of the present invention, a non-magnetic intermediate film of hcp structure may be provided under the second perpendicular magnetic film.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] **FIG. 1** is a partial sectional view showing an embodiment of the magnetic recording medium of the present invention.

[0017] **FIG. 2** is a partial sectional view showing another embodiment of the magnetic recording medium of the present invention.

[0018] **FIG. 3** is a partial sectional view showing yet another embodiment of the magnetic recording medium of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] **FIG. 1** is a schematic representation showing an embodiment of the magnetic recording medium of the present invention. The magnetic recording medium shown in **FIG. 1** comprises a substrate **1**, a first undercoat film **2**, a first perpendicular magnetic film **3**, a second undercoat film **4**, a non-magnetic intermediate film **5**, a second perpendicular magnetic film **6**, and a protective film **7**, the films **2** to **7** being successively formed on the substrate **1**.

[0020] The substrate **1** may be an aluminum alloy substrate on which an NiP plating film is formed, which is generally employed as a substrate for magnetic recording media; or a substrate of glass, ceramic, carbon, or flexible resin, which substrate may be coated with an NiP film through plating or sputtering.

[0021] The first undercoat film **2** is provided to enhance the perpendicular magnetic anisotropy of the first perpen-

dicular magnetic film **3**, and may be formed of SiN, Pd, C, Cu, Pt or MgO. The first undercoat film **2** has a thickness of 1,000 Å or less.

[0022] In an embodiment of the present invention, the first undercoat film may be omitted.

[0023] The first perpendicular magnetic film **3** is a film formed of magnetic material, in which most of the easy-magnetization axes are oriented vertically with respect to the substrate.

[0024] The first perpendicular magnetic film **3** may be a multi-layer film in which layers of Co material, and Pt or Pd material are stacked repeatedly.

[0025] Co material may be Co, a CoCr alloy, a CoCrPt alloy, a CoCrTa alloy, a CoCrPtX' alloy (X': one or more species selected from among Ta, Zr, Nb, Cu, Re, Ni, and B), or $CoSiO_2$ alloy.

[0026] Pt material may be Pt or a Pt alloy. Pd material may be Pd or a Pd alloy.

[0027] The first perpendicular magnetic film **3** may be an amorphous film containing a rare earth element; for example, an amorphous film formed of TbFeCo, GdCo, or NdDyFeCo or an ordered alloy, e.g., $L1_0$-structured FePt, CoPt, $(Fe_{(1-n)}Co_n)_{50}Pt_{50}$ (n: 0 - 0.99).

[0028] The ratio of residual magnetization to saturation magnetization (hereinafter referred to as "Mr/Ms") in the first perpendicular magnetic film **3** is preferably 0.9 or more. When Mr/Ms falls within the above range, the gradient in the vicinity of residual magnetization becomes small in the hysteresis, and demagnetization rarely occurs.

[0029] The first perpendicular magnetic film **3** preferably has a thickness of 1-175 Å, more preferably 1-100 Å.

[0030] When the thickness is below the above range, insufficient magnetic flux is obtained, which induces a reduction in read-write output and deterioration of noise characteristics such as SNR. In contrast, when the thickness exceeds the above range, medium noise increases due to exchange bonding in the first perpendicular magnetic film **3**.

[0031] In the magnetic recording medium of an embodiment of the present invention, the first perpendicular magnetic film **3** is a high-magnetic-anisotropy film in which the magnetic anisotropy energy is determined to be higher than that of the second perpendicular magnetic film **6**.

[0032] The first perpendicular magnetic film **3** preferably has a magnetic anisotropy energy of 5×10^6 erg/cc or more, more preferably 1×10^7 erg/cc or more.

[0033] When the magnetic anisotropy energy is below the above range, magnetic fluctuation tends to arise on the surface of the second perpendicular magnetic film **6**, which causes an increase in noise. In addition, coercive force (Hc) and magnetic anisotropy field (Hk) are reduced, and thermal stability is lowered.

[0034] The second undercoat film **4** is provided to enhance the crystal orientation of the non-magnetic intermediate film **5** and the second perpendicular magnetic film **6** and to enhance the perpendicular magnetic anisotropy of the film **6**. The film **4** preferably comprises a material of hcp structure.

[0035] The second undercoat film **4** may be formed of a material containing one or more species selected from among Ru, Ti, Zr, C, Re, Y, Gd, Tb, and Hf as a primary component. The material may comprise any one of Ru, Ti, Zr, C, Re, Y, Gd, and Tb as a single element. Alternatively, the material may comprise an alloy containing any of these elements and Cr, Co, Fe, or Ni, in consideration of lattice matching of the film **4** with respect to the films adjacent thereto (i.e., the first perpendicular magnetic film **3** and the second undercoat film **4**).

[0036] The second undercoat film **4** preferably has a thickness of 1,000 Å or less. When the thickness exceeds the above range, crystal grains become large in the film **4**, and this causes crystal grains to become large in the non-magnetic intermediate film **5** and the second perpendicular magnetic film **6**, resulting in deterioration of noise characteristics.

[0037] In an embodiment of the present invention, the second undercoat film may be omitted.

[0038] The non-magnetic intermediate film **5** is provided to enhance the crystal orientation of the second perpendicular magnetic film **6** formed on the film **5** and to enhance the perpendicular magnetic anisotropy of the second perpendicular magnetic film **6**. The film **5** preferably comprises a non-magnetic material of hcp structure.

[0039] The material of the non-magnetic intermediate film **5** preferably comprises any alloy selected from among CoCr, CoCrPt, CoCrTa, and CoCrPtX' (X': one or more species selected from among Ta, Zr, Nb, Cu, Re, Ni, and B).

[0040] Particularly, the material of the non-magnetic intermediate film **5** comprises, as a primary component, a Co alloy containing Cr: 25-50 at %, Pt: 0-15 at %, X': 0-10 at %, and Co: the balance is preferred.

[0041] The non-magnetic intermediate film **5** may either have a single-layer structure or a multi-layer structure. In the case of a multi-layer structure, the film **5** may be formed of a plurality of layers comprising a single material, or of a plurality of layers of different materials selected from the above-described materials.

[0042] The non-magnetic intermediate film **5** preferably has a thickness of 500 Å or less.

[0043] When the thickness is in excess of 500 Å, crystal grains tend to become large in the non-magnetic intermediate film **5** and magnetic grains may become large in the second perpendicular magnetic film **6**, and thus noise characteristics tend to deteriorate.

[0044] The non-magnetic intermediate film **5** more preferably has a thickness of 50-200 Å. Even when the non-magnetic intermediate film **5** has a multi-layer structure, the film has an overall thickness of 500 Å or less, preferably 50-200 Å.

[0045] In an embodiment of the present invention, the non-magnetic intermediate film may be omitted.

[0046] The second perpendicular magnetic film **6** comprises a magnetic material in which most of the easy-magnetization axes are oriented vertically with respect to the substrate. The material of the film **6** preferably comprises any alloy selected from among CoCrPt, CoCrTa, and

CoCrPtX (X: one or more species selected from among Ta, Zr, Cu, Re, Nb, Si, Ge, and B).

[0047] The second perpendicular magnetic film **6** more preferably comprises a Co alloy containing Cr: 13-25 at %, Pt: 0-18 at % (more preferably 0-15 at %), X: 0-5 at %, and Co: the balance. When the amount of each component falls outside the above range, noise characteristics deteriorate or read-write output decreases, which is unsatisfactory.

[0048] The second perpendicular magnetic film **6** preferably has a thickness of 100-1,000 Å. When the thickness of the film **6** is less than 100 Å, insufficient magnetic flux is obtained, thereby reducing read-write output and deteriorating noise characteristics such as SNR.

[0049] In contrast, when the thickness of the second perpendicular magnetic film **6** is in excess of 1,000 Å, magnetic grains in the film **6** become large, and thus noise characteristics deteriorate, which is unsatisfactory.

[0050] The second perpendicular magnetic film **6** more preferably has a thickness of 200-700 Å, more preferably 100-500 Å. When the thickness falls within this range, read-write output can be further enhanced, and magnetic grains in the film **6** can be prevented from becoming large, thereby improving noise characteristics.

[0051] In another magnetic recording medium of an embodiment of the present invention, the second perpendicular magnetic film **6** is a low magnetic anisotropy film in which the magnetic anisotropy energy is determined to be lower than that of the first perpendicular magnetic film.

[0052] When the magnetic anisotropy energy exceeds the above range (i.e., when the magnetic anisotropy energy is equal to or higher than that of the first perpendicular magnetic film), the boundaries of recording magnetic domains become non-linear; i.e., the boundaries tend to become jagged. Therefore, when recording density is increased, the effect of noise generated from the boundaries of the magnetic domains becomes large, and thus noise characteristics of the magnetic recording medium deteriorate.

[0053] The protective film **7** is provided to prevent corrosion of the second perpendicular magnetic film **6**, to protect the surface of the medium from any damage when a head contacts the medium, and to enhance lubrication between the head and the medium. Conventional materials may be employed for the film **7**, and examples of the materials include a single composition of C, SiO_2, or ZrO_2, a composition comprising C, SiO_2, or ZrO_2 as a primary component and other elements.

[0054] The protective film **7** preferably has a thickness of 10-100 Å.

[0055] On the surface of the protective film **7**, a lubrication film formed of perfluoropolyether, fluorinated alcohol, or fluorinated carboxylic acid is preferably provided.

[0056] In order to produce the magnetic recording medium comprising the above-described structure, firstly, the first undercoat film **2**, the first perpendicular magnetic film **3**, the second undercoat film **4**, the non-magnetic intermediate film **5**, and the second perpendicular magnetic film **6** are successively formed on the substrate **1** by means of a technique such as sputtering, vacuum deposition, or ion-plating. Subsequently, the protective film **7** may be formed on the film **6** by means of plasma CVD, an ion-beam method, or sputtering.

[0057] Incidentally, in order to form a lubrication film, a customary method such as dipping or spin coating may be employed.

[0058] In another magnetic recording medium of an embodiment of the present invention, the second perpendicular magnetic film **6** of low magnetic anisotropy is provided on the first perpendicular magnetic film **3** of high magnetic anisotropy, and thus noise characteristics can be enhanced.

[0059] In the medium comprising the above-described structure, noise characteristics can be enhanced for the reasons described below.

[0060] In general, a magnetic recording medium comprising a magnetic film of high magnetic anisotropy has a large coercive force, and thus read-write output can be enhanced. However, the boundaries of recording magnetic domains become non-linear; i.e., the boundaries tend to be jagged. Therefore, when recording density is increased, magnetic reversal occurs in the vicinity of the boundaries, thereby forming unclear boundaries. As a result, noise tends to increase.

[0061] In contrast, in a magnetic recording medium comprising a magnetic film of low magnetic anisotropy, recording magnetic domains having linear boundaries tend to be formed, and thus noise may be suppressed. However, in such a medium, increasing read-write output is difficult compared with a magnetic recording medium comprising a magnetic film of high magnetic anisotropy.

[0062] In another magnetic recording medium of an embodiment of the present invention, the first perpendicular magnetic film **3** of high magnetic anisotropy is provided under the second perpendicular magnetic film **6** of low magnetic anisotropy, and thus the distance between the film **3** and a magnetic head is long during read-write.

[0063] Therefore, even when the boundaries of recording magnetic domains become non-linear and magnetic reversal tends to occur in the first perpendicular magnetic film **3** of high magnetic anisotropy, noise is rarely detected and noise levels can be suppressed.

[0064] Meanwhile, the distance between the second perpendicular magnetic film **6** and a magnetic head is short during read-write, and thus noise tends to be detected. However, since the first perpendicular magnetic film **3** of high magnetic anisotropy is provided, magnetic fluctuation can be prevented in the second perpendicular magnetic film **6** due to magnetic bonding between the film **3** and the film **6**. Thus, an increase in noise can be prevented.

[0065] In addition, since the magnetic anisotropy of the second perpendicular magnetic film **6** is determined to be lower, the boundaries of recording magnetic domains in the film **6** become linear and noise attributed to the film **6** can be suppressed.

[0066] Furthermore, read-write output can be increased, because the first perpendicular magnetic film **3**, which has high magnetic anisotropy and a large coercive force, is provided.

[0067] Since the second perpendicular magnetic film **6** is provided (the distance between the film and a magnetic head is short during read-write), spacing loss can be reduced and read-write output can further be increased even when recording density is increased.

[0068] As described above, in the magnetic recording medium of the embodiment, noise can be suppressed, read-write output level can be increased, and noise characteristics, such as SNR, can be enhanced. Therefore, recording density can be increased.

[0069] In general, thermal stability is excellent in a medium that has large magnetocrystalline anisotropy (Ku). This is because when magnetocrystalline anisotropy (Ku) is strong, the gradient in the vicinity of residual magnetization is low in the hysteresis loop and demagnetization rarely occurs.

[0070] In another magnetic recording medium of an embodiment of the present invention, since coercive force (Hc) and magnetic anisotropy field (Hk) are increased due to the provision of the first perpendicular magnetic film **3** of high magnetic anisotropy, thermal stability can be enhanced.

[0071] As used herein, the term "thermal stability" refers to the degree of difficulty in occurrence of thermal decay.

[0072] The term "thermal decay" refers to a phenomenon in which recording bits become unstable and recorded data are thermally lost. When such a phenomenon occurs, read-write output of recorded data may decrease with passage of time.

[0073] In the magnetic recording medium, the non-magnetic intermediate film **5** of hcp structure is provided between the second undercoat film **4** and the second perpendicular magnetic film **6**. Thus, disturbance of crystal orientation in the film **6** is prevented at initial growth thereof. As a result, the crystal orientation and magnetic anisotropy of the film **6** are improved, coercive force and magnetic anisotropy field are easily set at a predetermined value, and noise characteristics and thermal stability can be reliably enhanced.

[0074] The improvement of crystal orientation of the second perpendicular magnetic film **6** may be attributed to enhancement of lattice matching between the film **6** and the non-magnetic intermediate film **5** which is made to have an hcp structure.

[0075] Since the non-magnetic intermediate film **5** is provided, the distance between the first perpendicular magnetic film **3** and the second perpendicular magnetic film **6** is long. Therefore, the distance between the film **3** and a magnetic head becomes long during read-write, and thus noise levels can be reduced.

[0076] The magnetic recording medium having the above-described structure comprises the non-magnetic intermediate film **5** which is formed of a material of hcp structure. However, the magnetic recording medium of the present invention is not particularly limited to the above-described embodiment, and the non-magnetic intermediate film **5** may be omitted. The magnetic recording medium not comprising the non-magnetic intermediate film **5** is shown in **FIG. 2**. Both the second undercoat film and the non-magnetic intermediate film **5** may be omitted. The second perpendicular magnetic film **6** are formed directly on the first perpendicular magnetic film **3**. Accordingly, the first undercoat film **2** is provided in the above-described magnetic recording medium, but the film **2** may be omitted in the present invention. The magnetic recording medium not comprising the first undercoat film **2** is shown in **FIG. 3**.

[0077] As used herein, the term "primary component" refers to a component which is contained in an amount of more than 50 at %.

[0078] It is preferable to form a soft magnetic layer (soft-back layer) between the substrate **1** and the first undercoat film **2**.

[0079] The material of the soft magnetic layer comprises material containing Co or Fe (e.g., alloys of CoZrNb, CoTaNb, permalloy, sendust FeTaC).

[0080] The thickness of the soft magnetic layer is preferably 50 nm or more (preferably 100 nm or more, more preferably 200 nm or more).

[0081] When the thickness of the soft magnetic layer is below the above range, it becomes difficult to form the loop-like magnetization curves.

EXAMPLES

[0082] The present invention will next be described in detail by way of specific examples. The magnetic recording medium shown in **FIG. 1, 2** or **3** was produced as follows. Unless otherwise indicated herein, all parts, percents, ratios and the like are by weight.

Test Example 1

[0083] A glass substrate **1** (diameter: 95 mm, thickness: 0.8 mm) was set in the chamber of a DC magnetron sputtering apparatus (model 3010: product of ANELVA Corporation). Subsequently, the chamber was evacuated to 2×10^{-7} Pa. Thereafter, on the substrate **1**, a first undercoat film **2** comprising SiN, a first perpendicular magnetic film **3** comprising TbFeCo, a second undercoat film **4** comprising Ru, a non-magnetic intermediate film **5** comprising Co-35at %Cr-5at %Pt (Co35Cr5Pt), and a second perpendicular magnetic film **6** comprising Co-20 at %Cr-10 at %Pt-3 at %Ta (Co20Cr10Pt3Ta) were sequentially formed by sputtering. After forming a first perpendicular magnetic film **3**, the substrate **1** was heated to 200° C.

[0084] On the second perpendicular magnetic film **6**, a carbon protective film **7** having a thickness of 70 Å was formed through plasma CVD.

[0085] On the carbon protective film **7**, a perfluoroether lubrication film (thickness: 20 Å) was formed through dipping.

[0086] In the magnetic recording medium, the magnetic anisotropy energy of the first perpendicular magnetic film **3** was determined to be higher than that of the second perpendicular magnetic film **6**.

Test Example 2

[0087] The procedure of Test Example 1 was repeated, except that the first undercoat film **2** and the first perpendicular magnetic film **3** were not provided to produce a magnetic recording medium.

Test Examples 3 through 6

[0088] The procedure of Test Example 1 was repeated, except that different materials were employed for the first undercoat film **2** and the first perpendicular magnetic film **3** to produce a magnetic recording medium.

Test Examples 7 through 9

[0089] The procedure of Test Example 1 was repeated, except that the thickness of the first perpendicular magnetic film **3** was changed to produce a magnetic recording medium.

Test Examples 10 and 11

[0090] The procedure of Test Example 1 was repeated, except that a different material was employed for the first perpendicular magnetic film **3** to produce a magnetic recording medium.

Test Examples 12 through 14

[0091] The procedure of Test Example 1 was repeated, except that a different material was employed for the second undercoat film **4** to produce a magnetic recording medium.

Test Examples 15 through 17

[0092] The procedure of Test Example 1 was repeated, except that the thickness of the non-magnetic intermediate film **5** was changed to produce a magnetic recording medium.

Test Example 18 through 20

[0093] The procedure of Test Example 1 was repeated, except that the composition of the second perpendicular magnetic film **6** was changed to produce a magnetic recording medium.

Test Examples 21 through 24

[0094] The procedure of Test Example 1 was repeated, except that the thickness of the second perpendicular magnetic film **6** was changed to produce a magnetic recording medium.

Test Example 25

[0095] The procedure of Test Example 1 was repeated, except that the first undercoat film **2** was not provided to produce a magnetic recording medium.

Test Example 26

[0096] The procedure of Test Example 1 was repeated, except that the non-magnetic intermediate film **5** was not provided to produce a magnetic recording medium.

Test Example 27

[0097] The procedure of Test Example 1 was repeated, except that the first undercoat film **2** and the first perpendicular magnetic film **3** were not provided to produce a magnetic recording medium.

[0098] The magnetic anisotropy energy of the perpendicular magnetic film **6** was determined at 7×10^6 erg/cc.

Test Example 28

[0099] The procedure of Test Example 1 was repeated, except that the first undercoat film **2** and the first perpendicular magnetic film **3** were not provided to produce a magnetic recording medium.

[0100] The magnetic anisotropy energy of the perpendicular magnetic film **6** was determined at 1×10^6 erg/cc.

Test Example 29

[0101] The procedure of Test Example 1 was repeated, except that the second undercoat film **4** and non-magnetic intermediate film **5** were not provided and different materials were employed for the first perpendicular magnetic film **3**.

Test Examples 30 through 31

[0102] The procedure of Test Example 1 was repeated, except that the different materials were employed for the first undercoat film **2** and the first perpendicular magnetic film **3**.

Test Example 32

[0103] The procedure of Test Example 1 was repeated, except that the different materials and thickness were employed for the second perpendicular magnetic film **6**.

Test Example 33

[0104] The procedure of Text Example 1 was repeated, except that the soft-back layer was provided and different materials and thickness were employed for the second perpendicular magnetic film **6**.

[0105] The magnetic recording media produced in the above test examples were subjected to measurement of magnetostatic characteristics by use of a Kerr effect measurement apparatus. In addition, the magnetic recording media were subjected to measurement of electromagnetic conversion characteristics, e.g., signal to noise ratio (SNR) by use of read/write analyzer RWA1632 and spin stand S1701MP (products of GURIK). In order to evaluate SNR, measurement was performed by use of a complex-type thin film magnetic recording head containing a giant magnetoresistance (GMR) element at a read-write portion as a magnetic head, and track-recording density was set at 150 kFCI. Table 1 shows the results of measurement of the magnetic recording media in the above-described Test Examples in terms of magnetostatic characteristics and SNR.

[0106] In addition, the magnetic recording media were subjected to measurement of thermal decay by use of the aforementioned complex-type thin film magnetic recording head as a magnetic head at a track recording density of 150 KFCI and a temperature of 25° C. In order to obtain thermal decay, the rate of reduction in output (%/decade) with respect to output immediately after recording was calculated on the basis of $\log\{(S_0-S)\times100/S_0\}/3$. The results are shown in Table 1. As used herein, S_0 represents output immediately after signals are written in the magnetic recording medium, and S represents output 1,000 seconds after the writing of the signals.

[0107] In Table 1, the symbol "element A/element B" refers to a multi-layer film which is formed by alternately and repeatedly stacking layers of elements A and B.

TABLE 1-1

	First undercoat film		First perpendicular magnetic film		Second undercoat film		Non-magnetic intermediate film	
	Composition	Thickness (Å)	Composition	Thickness (Å)	Composition	Thickness (Å)	Composition	Thickness (Å)
Test Ex.1	SiN	200	TbFeCo	50	Ru	100	Co35Cr5Pt	100
Test Ex. 2	—	—	—	—	Ru	100	Co35Cr5Pt	100
Test Ex. 3	Pt	100	Co/Pt	50	Ru	100	Co35Cr5Pt	100
Test Ex. 4	Pt	100	Co/Pd	50	Ru	100	Co35Cr5Pt	100
Test Ex. 5	Pt	100	CoCr/Pt	50	Ru	100	Co35Cr5Pt	100
Test Ex. 6	Pt	100	CoCr/Pd	50	Ru	100	Co35Cr5Pt	100
Test Ex. 7	SiN	200	TbFeCo	10	Ru	100	Co35Cr5Pt	100
Test Ex. 8	SiN	200	TbFeCo	100	Ru	100	Co35Cr5Pt	100
Test Ex. 9	SiN	200	TbFeCo	200	Ru	100	Co35Cr5Pt	100
Test Ex. 10	SiN	200	GdCo	50	Ru	100	Co35Cr5Pt	100
Test Ex. 11	SiN	200	NdDyFeCo	50	Ru	100	Co35Cr5Pt	100
Test Ex. 12	SiN	200	TbFeCo	50	Ti	100	Co35Cr5Pt	100
Test Ex. 13	SiN	200	TbFeCo	50	Zr	100	Co35Cr5Pt	100
Test Ex. 14	SiN	200	TbFeCo	50	C	100	Co35Cr5Pt	100

	Second perpendicular magnetic film			First perpendicular magnetic film		Electro-magnetic conversion	
	Composition	Thickness (Å)	Coercive force (Oe)	Anisotrophy energy (erg/cc)	Mr/Ms (-)	characteristics SNR (db)	Thermal decay (%/decade)
Test Ex.1	Co20Cr10Pt3Ta	500	4500	2.0E + 07	0.99	22.20	0.05
Test Ex. 2	Co20Cr10Pt3Ta	500	3500			18.60	0.40
Test Ex. 3	Co20Cr10Pt3Ta	500	4200	4.0E + 07	0.97	20.10	0.10
Test Ex. 4	Co20Cr10Pt3Ta	500	4200		0.99	20.20	0.08
Test Ex. 5	Co20Cr10Pt3Ta	500	4200	1.0E + 07	0.96	20.30	0.12
Test Ex. 6	Co20Cr10Pt3Ta	500	4200		0.96	20.20	0.12
Test Ex. 7	Co20Cr10Pt3Ta	500	3800		0.91	22.00	0.08
Test Ex. 8	Co20Cr10Pt3Ta	500	4100		0.99	20.50	0.03
Test Ex. 9	Co20Cr10Pt3Ta	500	4300		1.00	17.50	0.02
Test Ex. 10	Co20Cr10Pt3Ta	500		1.5E + 07	0.96	20.60	0.05
Test Ex. 11	Co20Cr10Pt3Ta	500		1.0E + 07	0.95	20.40	0.05
Test Ex. 12	Co20Cr10Pt3Ta	500	4300			20.20	0.04
Test Ex. 13	Co20Cr10Pt3Ta	500	4000			20.20	0.04
Test Ex. 14	Co20Cr10Pt3Ta	500	4200			21.50	0.06

[0108]

TABLE 1-2

	First undercoat film		First perpendicular magnetic film		Second undercoat film		Non-magnetic intermediate film	
	Composition	Thickness (Å)	Composition	Thickness (Å)	Composition	Thickness (Å)	Composition	Thickness (Å)
Test Ex. 15	SiN	200	TbFeCo	50	Ru	100	Co35Cr5Pt	20
Test Ex. 16	SiN	200	TbFeCo	50	Ru	100	Co35Cr5Pt	500
Test Ex. 17	SiN	200	TbFeCo	50	Ru	100	Co35Cr5Pt	800
Test Ex. 18	SiN	200	TbFeCo	50	Ru	100	Co35Cr5Pt	100
Test Ex. 19	SiN	200	TbFeCo	50	Ru	100	Co35Cr5Pt	100
Test Ex. 20	SiN	200	TbFeCo	50	Ru	100	Co35Cr5Pt	100
Test Ex. 21	SiN	200	TbFeCo	50	Ru	100	Co35Cr5Pt	100
Test Ex. 22	SiN	200	TbFeCo	50	Ru	100	Co35Cr5Pt	100
Test Ex. 23	SiN	200	TbFeCo	50	Ru	100	Co35Cr5Pt	100
Test Ex. 24	—	—	TbFeCo	50	Ru	100	Co35Cr5Pt	100
Test Ex. 25	SiN	200	TbFeCo	50	Ru	100	—	—
Test Ex. 26	—	—	—	—	Ru	100	Co35Cr5Pt	100
Test Ex. 27	—	—	—	—	Ru	100	Co35Cr5Pt	100
Test Ex. 28								

	Second perpendicular magnetic film			First perpendicular magnetic film		Electromagnetic conversion	
	Composition	Thickness (Å)	Coercive force (Oe)	Anisotrophy energy (erg/cc)	Mr/Ms (–)	characteristics SNR (db)	Thermal decay (%/decade)
Test Ex. 15	Co20Cr10Pt3Ta	500	3900			22.30	0.04
Test Ex. 16	Co20Cr10Pt3Ta	500	4300			21.80	0.07
Test Ex. 17	Co20Cr10Pt3Ta	500	3600			17.80	0.15
Test Ex. 18	Co21Cr10Pt	500	4400			20.40	0.04
Test Ex. 19	Co22Cr12Pt4B	500	4400			22.20	0.05
Test Ex. 20	Co21Cr8Pt2Ta2Zr	500	4000			20.90	0.06
Test Ex. 21	Co20Cr10Pt3Ta	50	2600			15.80	0.05
Test Ex. 22	Co20Cr10Pt3Ta	100	3700			20.40	0.05
Test Ex. 23	Co20Cr10Pt3Ta	1000	4000			20.40	0.04
Test Ex. 24	Co20Cr10Pt3Ta	1500	3800			18.50	0.03
Test Ex. 25	Co20Cr10Pt3Ta	500	4000		0.95	21.00	0.05
Test Ex. 26	Co20Cr10Pt3Ta	500	3800			21.00	0.04
Test Ex. 27	Co20Cr10Pt3Ta	500	3900	—	—	18.40	0.14
Test Ex. 28	Co20Cr10Pt3Ta	500	3900	—	—	20.80	0.38

[0109]

TABLE 1-3

			First undercoat film		First perpendicular magnetic film		Second undercoat film		Non-magnetic intermediate film	
	Soft back layer	Thickness (Å)	Composition	Thickness (Å)	Composition	Thickness (Å)	Composition	Thickness (Å)	Composition	Thickness (Å)
Test Ex. 29	—	—	Pt	200	CoCr/Pt	100	—	—	—	—
Test Ex. 30	—	—	MgO	100	FePt	100	—	—	—	—
Test Ex. 31	—	—	MgO	100	FePt	100	Ru	50	Co35Cr5Pt	50
Test Ex. 32	—	—	Pt	200	CoSiO2/Pd	150	—	—	—	—
Test Ex. 33	CoZrNB	3000	Pt	200	CoB/Pd	150	—	—	—	—

	Second perpendicular magnetic film			First perpendicular magnetic film		Electromagnetic conversion characteristics	
	Composition	Thickness (Å)	Coercive force (Oe)	Anisotrophy energy (erg/cc)	Mr/Ms (-)	SNR (db)	Thermal decay (%/decade)
Test Ex. 29	Co20Cr10Pt3Ta	300	4200	—	—	21.5	0.03
Test Ex. 30	Co20Cr10Pt2B	200	5300	7.00E + 07	0.98	22.5	0.01
Test Ex. 31	Co20Cr10Pt2B	300	5700	—	—	21.5	0.02
Test Ex. 32	Co20Cr10Pt2B	200	4800	—	—	22.9	0.04
Test Ex. 33	Co20Cr10Pt2B	200	5000	—	—	20.8	0.03

*In the column "anisotropy energy," "AE + B" refers to $A \times 10^B$.

[0110] As is apparent from Table 1, among Test Examples 1 through 6, the magnetic recording media of Test Examples 1 and 3 through 5 comprising the first perpendicular magnetic film **3** exhibited excellent noise characteristics compared with the magnetic recording medium of Test Example 2 which did not have the first perpendicular magnetic film **3**.

[0111] Comparison among Test Examples 1 and 7 through 9 revealed that the magnetic recording media of Test Examples 1, 7, and 8 comprising the first perpendicular magnetic film **3** having a thickness of 1-100 Å exhibited excellent noise characteristics compared with the magnetic recording medium of Test Example 9 comprising the film **3** having a thickness outside the above range.

[0112] Comparison among Test Examples 1, 10, and 11 revealed that the magnetic recording media comprising the first perpendicular magnetic film **3** formed of different materials shown in Table 1 exhibited excellent noise characteristics.

[0113] Comparison among Test Examples 1 and 12 through 14 revealed that the magnetic recording media comprising the second undercoat film **4** formed of different materials shown in Table 1 exhibited excellent noise characteristics.

[0114] Comparison among Test Examples 1 and 15 through 17 revealed that the magnetic recording media of Test Examples 1, 15, and 16 comprising the non-magnetic intermediate film **5** having a thickness of 500 Å or less (or the media not comprising the film **5**) exhibited excellent noise characteristics compared with the magnetic recording medium of Test Example 17 comprising the film **5** having a thickness outside the above range.

[0115] Comparison among Test Examples 1 and 18 through 20 revealed that the magnetic recording media comprising the second perpendicular magnetic film **6** formed of different compositions in the above-described range exhibited excellent noise characteristics.

[0116] Comparison among Test Examples 1 and 21 through 24 revealed that the magnetic recording media of Test Examples 1, 22, and 23 comprising the second perpendicular magnetic film **6** having a thickness of 100-1,000 Å exhibited excellent noise characteristics compared with the magnetic recording media of Test Examples 21 and 24 comprising the film **6** having a thickness outside the above range.

[0117] Comparison of Test Example 1 with Test Example 25 revealed that, although good noise characteristics can be obtained when a first undercoat film **2** is not provided, a structure with a first undercoat film **2** yields more excellent noise characteristics.

[0118] Comparison of Test Example 1 with Test Example 26 revealed that, although good noise characteristics can be obtained when a non-magnetic intermediate film **5** is not provided, a structure with a non-magnetic intermediate film **5** exhibits more excellent noise characteristics.

[0119] Comparison among Test Examples 1, 27, and 28 revealed that the magnetic recording medium of Test Example 1, which comprises the first and second perpendicular magnetic films **3** and **6**, in which the magnetic anisotropy energy of the film **3** is determined to be higher than that of the film **6**, exhibited excellent noise characteristics and thermal stability compared with the magnetic recording media of Test Examples 27 and 28, which did not comprise a first perpendicular magnetic film **3**, and exhibited either poor noise characteristics or lower thermal stability.

[0120] As described above, the magnetic recording medium of the present invention comprises a substrate, a first perpendicular magnetic film, and a second perpendicular magnetic film in order, in which the magnetic anisotropy energy of the first magnetic film is determined to be higher than that of the second magnetic film. Therefore, in the magnetic recording medium of the present invention, noise can be suppressed, read-write output can be increased, and noise characteristics such as SNR can be enhanced, and thus recording density can be increased.

[0121] In the magnetic recording medium of the present invention, a first perpendicular magnetic film of high magnetic anisotropy is provided, and thus coercive force and magnetic anisotropy field can be increased and thermal stability can be enhanced.

[0122] While the invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof.

What is claimed is:

1. A magnetic recording medium comprising a substrate, a first perpendicular magnetic film, and a second perpendicular magnetic film in order, wherein a magnetic anisotropy energy of the first perpendicular magnetic film is higher than that of the second perpendicular magnetic film.

2. A magnetic recording medium according to claim 1, wherein the first perpendicular magnetic film has a magnetic anisotropy energy of 5×10^6 erg/cc or more.

3. A magnetic recording medium according to claim 1, wherein a ratio of residual magnetization to saturation magnetization in the first perpendicular magnetic film is 0.9 or more.

4. A magnetic recording medium according to claim 2, wherein a ratio of residual magnetization to saturation magnetization in the first perpendicular magnetic film is 0.9 or more.

5. A magnetic recording medium according to claim 1, wherein the first perpendicular magnetic film is a multi-layer film comprising layers of Co material, and Pt or Pd material repeatedly stacked.

6. A magnetic recording medium according to claim 2, wherein the first perpendicular magnetic film is a multi-layer film comprising layers of Co material, and Pt or Pd material repeatedly stacked.

7. A magnetic recording medium according to claim 1, wherein the first perpendicular magnetic film is an amorphous film containing a rare earth element.

8. A magnetic recording medium according to claim 2, wherein the first perpendicular magnetic film is an amorphous film containing a rare earth element.

9. A magnetic recording medium according to claim 1 or 2, wherein the first perpendicular magnetic film comprises an ordered alloy selected from the group consisting of $L1_0$-structured FePt, CoPt or $(Fe_{(1-n)}Co_n)_{50}Pt_{50}$ (n: 0-0.99).

10. A magnetic recording medium according to claim 1, wherein the first perpendicular magnetic film has a thickness of 1-175 Å.

11. A magnetic recording medium according to claim 2, wherein the first perpendicular magnetic film has a thickness of 1-175 Å.

12. A magnetic recording medium according to claim 1, wherein the second perpendicular magnetic film comprises any alloy selected from the group consisting of CoCrPt, CoCrTa, and CoCrPtX, wherein X is one or more species selected from the group consisting of Ta, Zr, Cu, Re, Nb, Si, Ge, and B.

13. A magnetic recording medium according to claim 2, wherein the second perpendicular magnetic film comprises any alloy selected from the group consisting of CoCrPt, CoCrTa, and CoCrPtX, wherein X is one or more species selected from the group consisting of Ta, Zr, Cu, Re, Nb, Si, Ge, and B.

14. A magnetic recording medium according to claim 1, wherein a non-magnetic intermediate film of hcp structure is provided under the second perpendicular magnetic film.

15. A magnetic recording medium according to claim 2, wherein a non-magnetic intermediate film of hcp structure is provided under the second perpendicular magnetic film.

16. A magnetic recording medium according to claim 1 or 2, wherein a soft-back layer is formed under the first undercoat film.

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